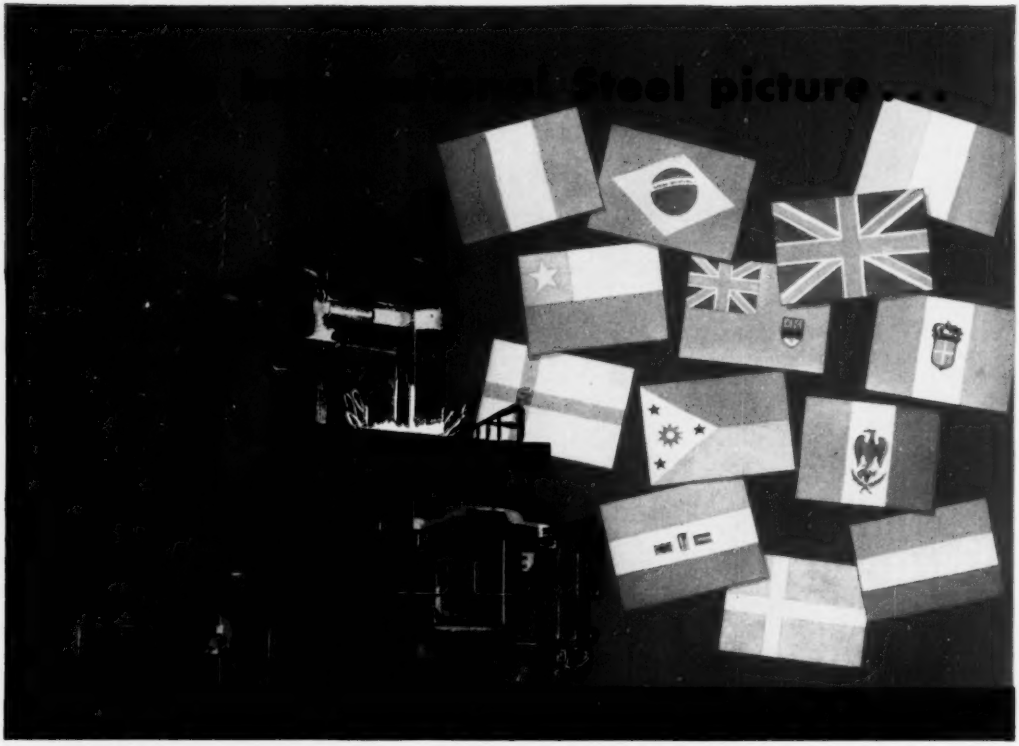
Foundryman



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Lectromelt top-charged electric arc furnaces, long a favorite among steel makers in the United States, also have an enviable international recognition. Furnaces are now being built in our plant at Pittsburgh and by our associates around the world.

Bold thinking throughout the years has kept Lectromelt in the lead. First to boost the power input to levels which doubled furnace output, first to lift the furnace top to speed production and cut costs, continuing to hold the line on high-quality, sturdy construction—these are typical reasons for the world-wide demand for Lectromelt Furnaces.

Whether your problem is melting, refining, smelting or reduction, let our engineers help you select the furnace you need. Write for Bulletin No. 7. Pittsburgh Lectromelt Furnace Corporation, 316 32nd Street, Pittsburgh 30, Pennsylvania.

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IS A PURE WYOMING BENTONITE OF PROVEN, PRACTICAL QUALITY USED IN ALL CLASSES OF FOUNDRY SAND IN GREY IRON, MALLEABLE AND STEEL FOUNDRY PRACTICE.
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These day-to-day benefits explain why leading foundries throughout the country regard Purite as the foremost cupola flux and ladle desulphurizing agent. Write today for specific information on how Purite can improve your iron. Mathieson Chemical Corporation, Mathieson Building, Baltimore 3, Maryland.

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100% FUSED SODA ASH

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VOLUME XVIII, NUMBER 4

American Foundryman

October, 1950

Official publication of American Foundrymen's Society

Editorial: Train Tomorrow's Foundrymen Today: F. C. Riecks

International Foundry Congress—Atlantic City, 1952

Three-Minute Quality Test for 85-5-5-5 Red Brass

Special Investment Casting Techniques: K. J. Yonker and G. A. Stolze

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Producing Malleable Cast Iron: Leo R. Friedman

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Summer Training Program for Future Foundrymen

The Round Table—Practical Questions and Answers

Foundry Practices for Aluminum Alloys: G. H. Bradshaw

Slagging Practice—A Means of Cupola Control: Thomas F. Hart

Colorimetric Determination of Nickel in Brasses and Bronzes: W. L. Miller and George Norwitz

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Chapter Meetings

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Foundry Literature

Foundry Firm Facts

Abstracts of Foundry Articles

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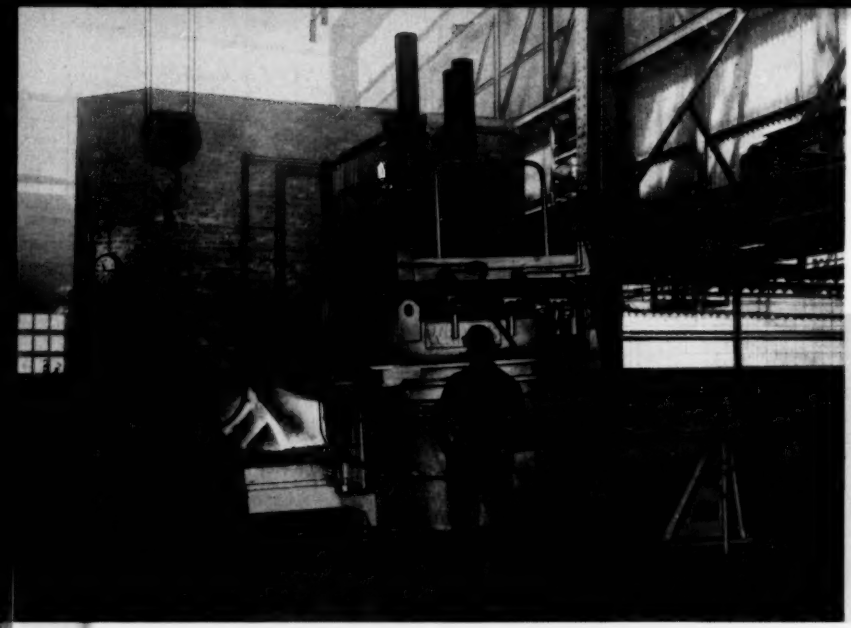
A.F.S. Employment Service

The American Foundrymen's Society is not responsible for statements or opinions advanced by authors of papers in its publication.

Checking patterns for double curved single cross trackwork castings at Canadian Car & Foundry Co.'s Longue Point plant, near Montreal, Que. For use at a street corner crossing, the castings are wear-resisting 13 per cent manganese steel poured in green sand. Molds are slinger-rammed with dry sand cores at the ends of the castings to form pockets for fish-plates which tie the crosses to the track segments. Weight is from 650 to 1000 lb.

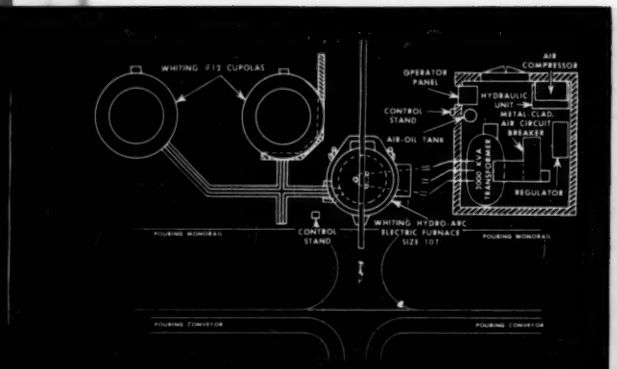
Published monthly by the American Foundrymen's Society, Inc., 616 S. Michigan Ave., Chicago 5. Subscription price in the U. S., Canada and Mexico, $3.00 per year; elsewhere, $6.00. Single copies, 50c. Entered as second class matter July 22, 1938, under Act of March 3, 1879, at the Post Office, Chicago, Illinois. EASTERN REPRESENTATIVE—Warren Thomson Mavers Co., 130 East 61st St., New York. CENTRAL REPRESENTATIVE—Enright & Cleary, 1836 Euclid Ave., Cleveland. MIDWESTERN REPRESENTATIVE—H. Thorpe Covington Co., 677 N. Michigan Ave., Chicago.



Duplexing installation in which hot metal is carried to the Hydro-Arc Furnace with a ladle.

Cupola-to-Electric DUPLEXING

— a solution to low-quality coke problems



Typical cupola-to-electric duplexing layout complete with pouring system

By using a Hydro-Arc Furnace that matches total cupola capacity, melters are increasing production, getting proper pouring temperatures at all times, and reducing machine shop rejections.

Other savings (such as continuity in pouring, increased yield from alloys, and finer grain castings of higher strength) help to make cupola-to-electric duplexing repay its entire cost in a comparatively short time.

The versatility of Hydro-Arc Electric Furnaces, combined with the ingenuity of Whiting engineers, make this equipment adaptable to almost any foundry requirements. A Whiting representative will gladly call to discuss it with you.

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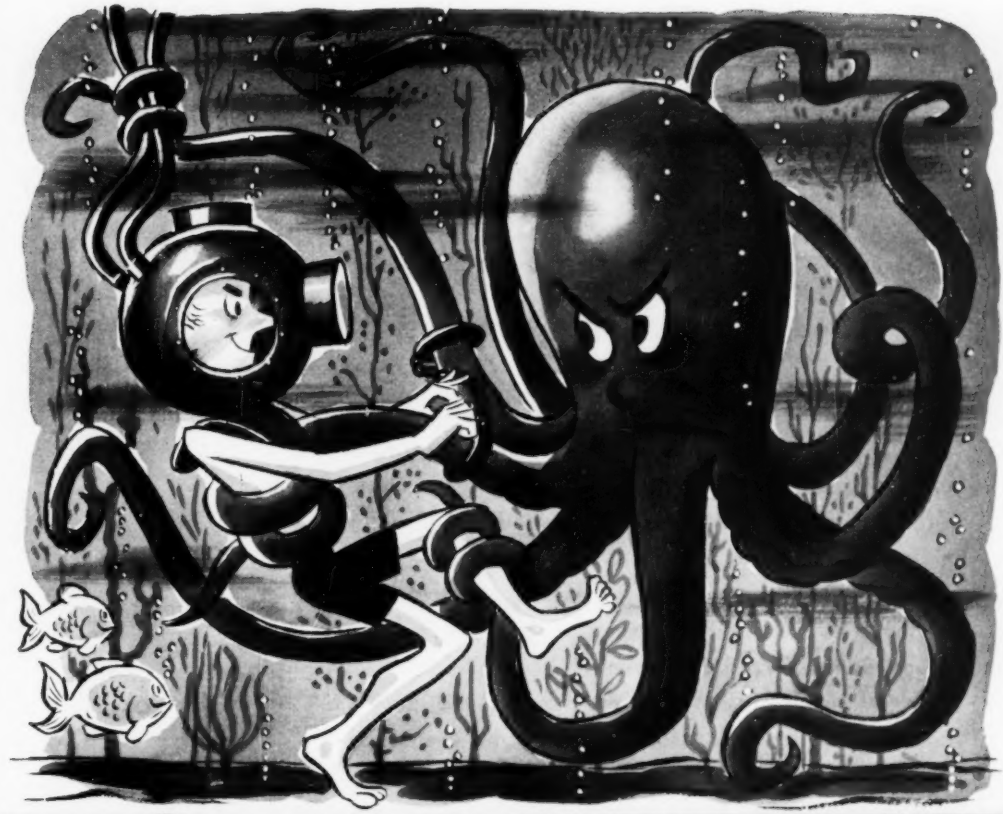

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With *all 10* of these important features for maximum foundry efficiency — Uniformity • Concentrated form • No obnoxious odor • No seepage • No crusting of green mix • Clean working • Wide temperature baking range • Polymerized formulation • Minimum gas • Ample collapsibility

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FOR ALL 'ROUND YEAR 'ROUND

EFFICIENCY

Home heating and ventilating engineers are busy right now improving **home ventilation balance,** because home owners will not tolerate last winters' heat loss, uncomfortable cold spots and the resulting high cost of heating bills.

How many foundry owners give the same amount of thought to **building ventilation balance** in their plants as they do in their homes?

In our meanderings through many foundries we have found glaring examples of heat and ventilation waste. Surely these plants deserve even more consideration than the home because efficiency is paramount if a profitable enterprise is to be maintained.

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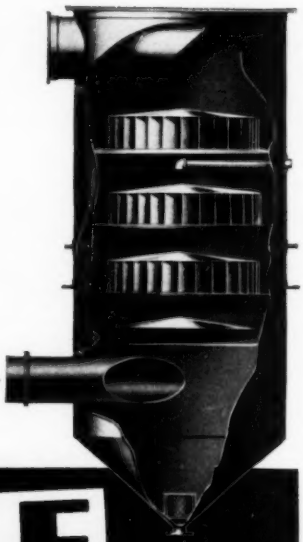


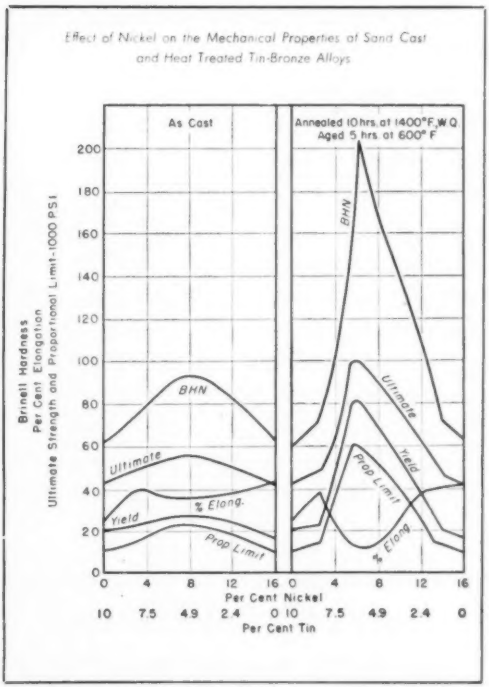
SCHNEIBLE

How Bronzes Containing NICKEL Provide Improved Properties

Copper-base alloys provide outstanding advantages to users and producers, alike. These are enhanced when moderate amounts of nickel are utilized.

HOW NICKEL IMPROVES CAST BRONZE

For instance . . . small percentages of nickel refine the grain, strengthen the alloy, and improve its resistance to wear and corrosion. By increasing fluidity in the casting mixture, nickel affords a wider casting range, and thus helps to minimize misruns and to improve density and pressure-tightness.


Effect of Nickel on the Mechanical Properties of Sand Cast and Heat Treated Tin-Bronze Alloys
As Cast
Annealed 10 hrs. at 1400°F, W.Q.
Aged 5 hrs. at 600° F
Brinell Hardness
Per Cent Elongation
Ultimate Strength and Proportional Limit-1000 PSI
BHN
Ultimate
Yield
% Elong.
Prop Limit
0 4 8 12 16 0 4 8 12 16
Per Cent Nickel
10 7.5 4.9 2.4 0 10 7.5 4.9 2.4 0
Per Cent Tin

RESPONSE TO HEAT TREATMENT

In certain cases, a moderate nickel content makes possible the response to heat treatment which increases the tensile and compressive strength, being particularly effective in raising elastic properties.

Certain cast nickel bronzes are very responsive to heat treatment. The hardness of an alloy containing 7.5 per cent nickel and 8 per cent tin, for example, can be increased from about 75 to 277 BHN by appropriate heat treatment.

TYPICAL APPLICATIONS

Typical applications of nickel bronzes include worm wheels, gears, liners, bushings, bearing backs, valve guides and seats, pumps, valves, fittings, plumbing goods, miscellaneous structural and engineering uses.

COUNSEL AND DATA

Nickel alloyed bronzes offer significant advantages. Whatever your industry, we solicit the opportunity to help you with counsel and data pertaining to these economical alloys. Write for recommendations regarding the best types for your applications. Mail the coupon now.

EMBLEM OF INCO SERVICE

The International Nickel Company, Inc.
Department AF, 67 Wall St., New York 5, N. Y.

Gentlemen:

Please send booklet: "The Role of Nickel in Cast Bronze."

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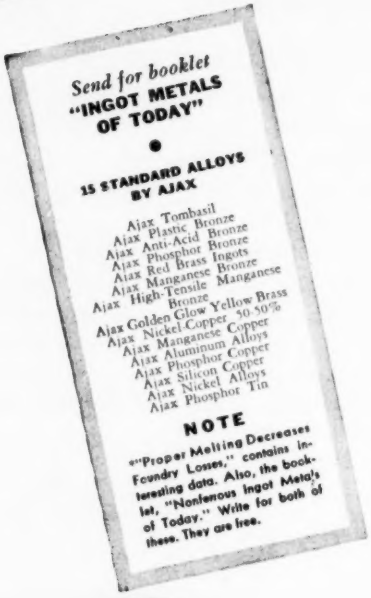
THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.

THE USE OF AJAX PHOSPHOR-COPPER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NOTE
"Proper Melting Decreases Foundry Losses," contains interesting data. Also, the booklet, "Nonferrous Ingot Metals of Today." Write for both of these. They are free.

Successful foundrymen deoxidize or "clean up" molten metal by a scientific method worth using *as indicated:*

They use phosphorus . . expertly . . in the form of "Ajax Phosphor Copper" . . added as the crucible is removed from the furnace . . for virtually all brass and bronze alloys.

In notched waffle sections, or in shot form, Ajax 15% P-Cu does its work at .01% (1 oz. per 100 lbs.). Introduced, and having time to react when stirred with a whirling motion of the skimmer, it causes oxides to rise for effective removal by skimming from the surface. It is best to avoid phosphorus build-up from back stock.* . . If you use phosphorus these days, use Ajax Phosphor Copper (useful also in producing your phosphor bronze)

AJAX METAL DIVISION
ESTABLISHED 1880 *of* **H. KRAMER & CO.**

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The Season's Over -

Famous CORNELL CUPOLA FLUX

Has a record of more than 32 years of casting improvement, and is constantly setting a new record for sales.

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THE USE OF FAMOUS CORNELL CUPOLA FLUX IS THE ECONOMICAL WAY TO THOROUGHLY CLEANSE MOLTEN METAL AND PRODUCE BETTER CASTINGS

Famous Cornell Cupola Flux costs but little to start with, and its exclusive scored brick form simplifies fluxing of molten iron, reduces labor to the minimum.

LEADING FOUNDRIES have been using it regularly, for years, as an essential guard against rejects and make-overs caused by impurities which exist in molten metal regardless of how carefully materials are selected.

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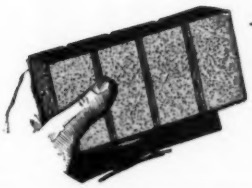

EXCLUSIVE SCORED BRICK FORM takes practically no time to use — only a few seconds, that's all.

Write for Bulletin No. 46-B

To flux a charge of iron, you simply lift Famous Cornell Cupola Flux from container and toss it into cupola with each ton charge of iron, or break off one to three briquettes (quarter sections) for smaller charges, as per instructions.

Famous CORNELL ALUMINUM FLUX

CLEANSES MOLTEN ALUMINUM so that you pour clean, tough castings. No spongy or porous spots even when more scrap is used. Thinner yet stronger sections can be poured. Castings take a higher polish. Exclusive Formula greatly reduces obnoxious gases, improves working conditions. Dross contains no metal after this flux is used.

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CLEANSES MOLTEN BRASS even when dirtiest brass turnings or sweepings are used. You pour clean, strong castings which withstand high pressure tests and take a beautiful finish. The use of this flux saves you considerable tin and other metals, and keeps crucible and furnace linings cleaner, adds to lining life and reduces maintenance.

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. . . dealing exclusively with the production and use of cores in the modern foundry

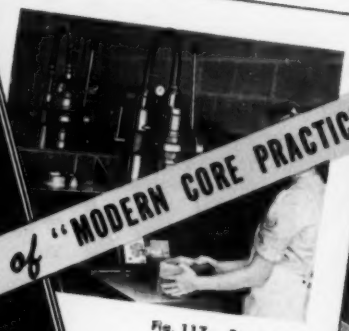

Fig. 117—Bench-type Core Blowing Machine

Fig. 190—High-frequency Dielectric Core Baking Oven

Written in practical, understandable language for operating men and metallurgists, FOUNDRY CORE PRACTICE covers the entire cycle of core-making operations . . . from materials and mining methods to final setting of cores and molds.

A complete 560-page handbook, containing 314 photographs, graphs, and sketches, 81 tables and an extensive bibliography, the text covers:

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FOR SKIN DRY . . .
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GREEN SAND . . .
MOLDS AND CORES

THE SUPERIOR, WATERPROOF ORGANIC BINDER THAT . . .

Cuts Production Costs!

DELTA BONDITE, the new waterproof organic binder for skin dry, dry sand and green sand molds and cores is a decidedly superior product . . . immediately available in any quantities . . . and considerably more economical to use.

HERE'S WHY . . .

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2. To produce the above properties, no chemical reaction takes place thus resulting in stable sand surfaces on which the molten metal lays kindly.
3. The volatile gases produced by decomposition of BONDITE, ahead of the molten metal, are reducing in nature. This helps eliminate rough casting surfaces, burning-in and metal penetration.
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8. Clays, Bentonite, silica flour, fines or old sand have only a minor effect on its binding properties.
9. It is economical to use, reduces cleaning costs and greatly improves casting surfaces and soundness.

* Covered by U. S. Patents No. 2256832 for foundry use.

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Complete data and specifications on the use of DELTA BONDITE will be mailed to you on request.

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This dry parting is also extremely economical to use. Because of its fine texture, a thinner film is required. And since it is white in color it is easy to see on the pattern frame, allowing a minimum of dusting. Customers report they use less—rather than more Sno-White parting and get better castings than ever before.

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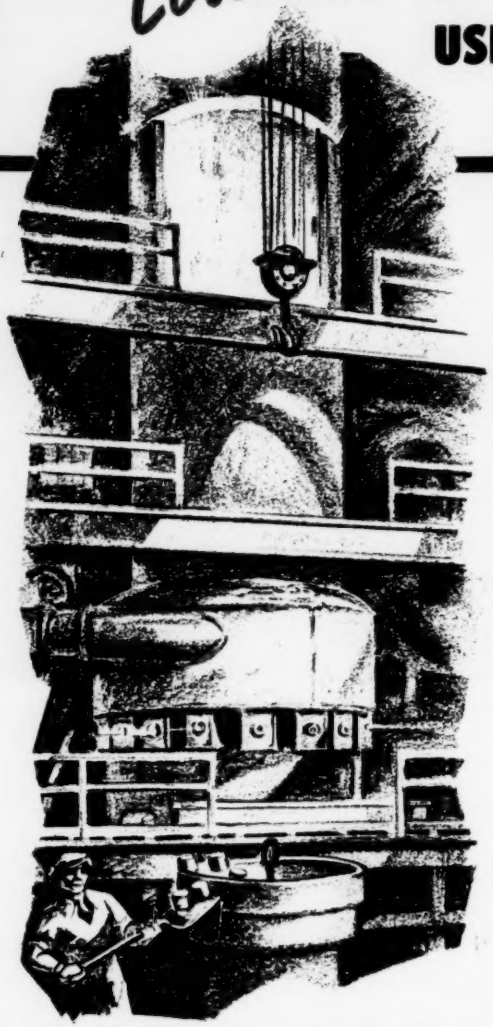
FOR *ECONOMICAL* CUPOLA OPERATION

USE OHIO FERRO-ALLOYS BRIQUETS



Economy is an important factor in every cupola operation. It will pay you to consider the advantages and resultant savings on material costs made possible by the use of Ohio Ferro-Alloys Briquets.

You may select the most economical charge of scrap and pig iron and adjust the analysis with these Briquets.

THE FOLLOWING ARE AVAILABLE

Kind of Ohio Ferro-Alloys Briquet	Color	Contained Alloy
Silicon	gray	Two Sizes { 1 lb. Silicon / 2 lb. Silicon
Silico-Manganese	yellow	½ lb. Silicon and 2 lb. Manganese
Manganese	red	2 lb. Manganese
Chrome	green	2 lb. Chromium

Ohio Ferro-Alloy Briquets are available in bulk, packed in steel drums, or in box type pallets for lift truck handling. Immediate shipment from stock at plants located at Philo, Ohio—Tacoma, Washington, and warehouses at San Francisco, California, Los Angeles, California and Minneapolis, Minnesota.

FERRO-SILICON 25 - 50 - 65 - 75 - 85 - 90%
SPECIAL BLOCKING 50% FERRO-SILICON
LOW CARBON FERRO-CHROME SILICON
HIGH CARBON FERRO-CHROME
FERRO-MANGANESE • BOROSIL • SIMANAL

BRIQUETS
SILICON • MANGANESE • CHROME
SILICO - MANGANESE

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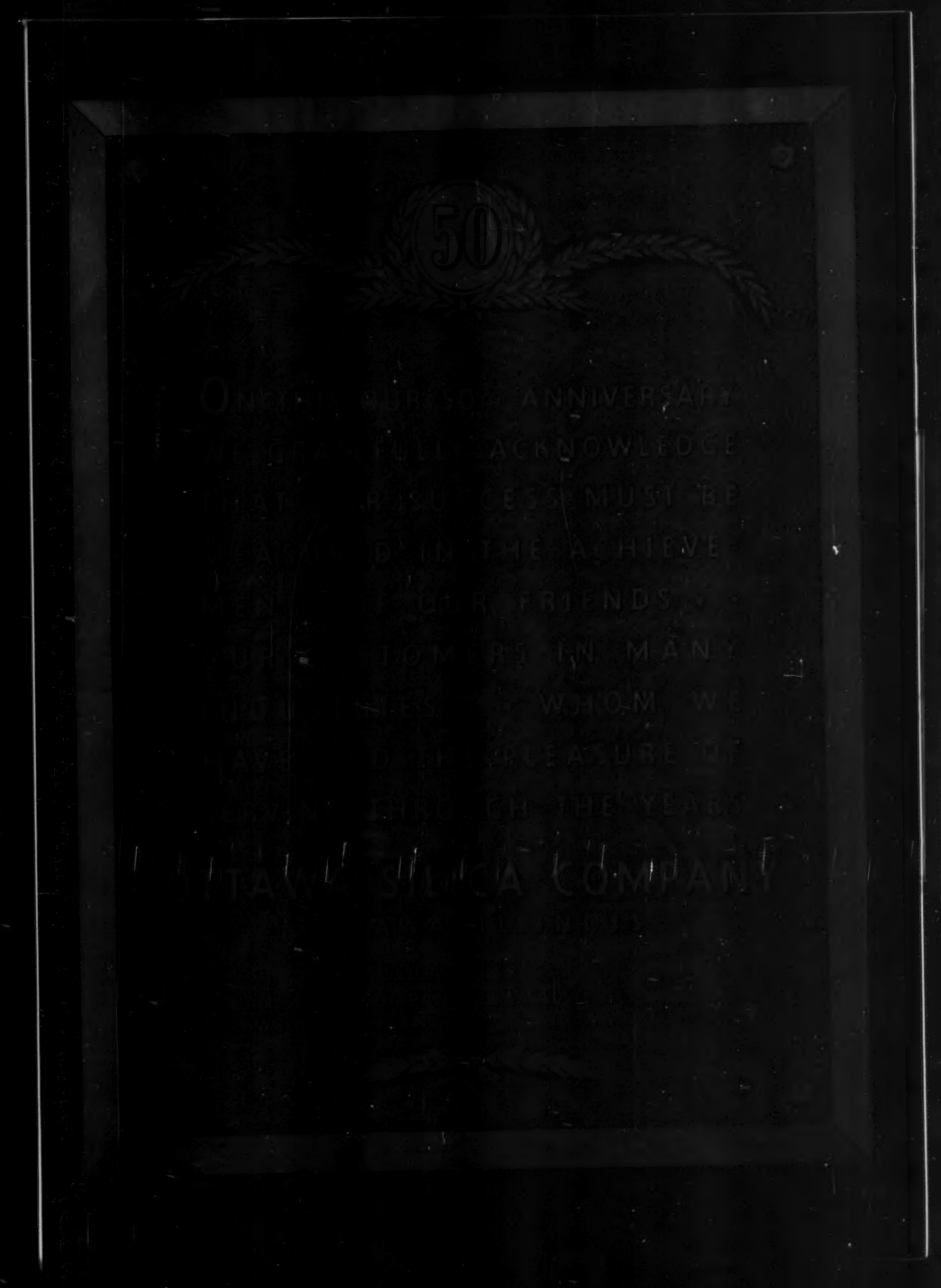
Ohio Ferro-Alloys Corporation
Canton, Ohio

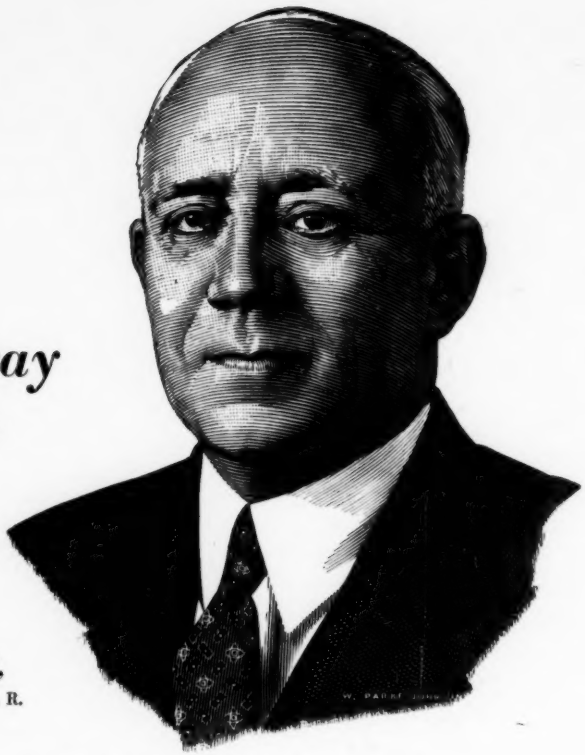
Chicago Detroit Pittsburgh San Francisco
Minneapolis Birmingham Los Angeles Tacoma

Sales Agents & Warehouses
San Francisco Area: Pacific Graphite Co., Inc., Oakland 8, California
Los Angeles Area: Snyder Foundry Supply Co., Los Angeles 11, California
Minneapolis Area: Foundry Supply Co., Minneapolis, Minnesota

Sales Agents:
E. A. Wilcox Co., Arctic Bldg., Seattle 4, Washington; Phone—Seneca 0193
Schuler Equipment Co., First National Bldg., Birmingham, Alabama


50
ILLINOIS SILICA COMPANY

"The easiest way to buy Bonds..."



MR. MARTIN W. CLEMENT,
Chairman of the Board, Pennsylvania R. R.

"The easiest way to buy bonds is through the payroll savings plan. We on the Pennsylvania believe in that plan. Labor and management, officers and employees, over half of us are enjoying it. We believe that it is good for our country, that it is good for our company, and that it is good for ourselves and our families to have these savings."

Top executives of more than 20,000 large companies share Mr. Clement's conviction that the Payroll Savings Plan is good for the country, the company, the employees and their families.

Obviously it is good for the country. The monthly purchase of Savings Bonds by more than 8,000,000 Americans is building a huge fund of buying dollars that will be reflected in the sales curves of tomorrow.

And certainly it is good for the company. The employee who puts a part of his earnings in Savings Bonds *every month* is not the type of man whose name appears frequently on the absentee or accident records. Serious savers are serious—productive workers.

For the employee, the Payroll Savings Plan is a positive boon. It is the easy, automatic way for him to build financial independence, provide for the education of children or save money for a home.

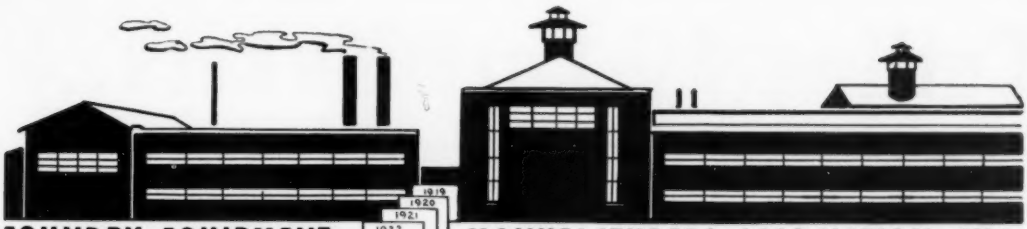
If your company does not have a Payroll Savings Plan, here are two things you can do *today:*

Appoint a Bond Officer, one of your major executives—the kind of man who picks up a ball and runs with it. Tell him to get in touch with the State Director, Savings Bond Division, U. S. Treasury Department. The State Director is ready with a package plan—application cards, promotional material, practical suggestions, and all the personal assistance your Bond Officer may need.

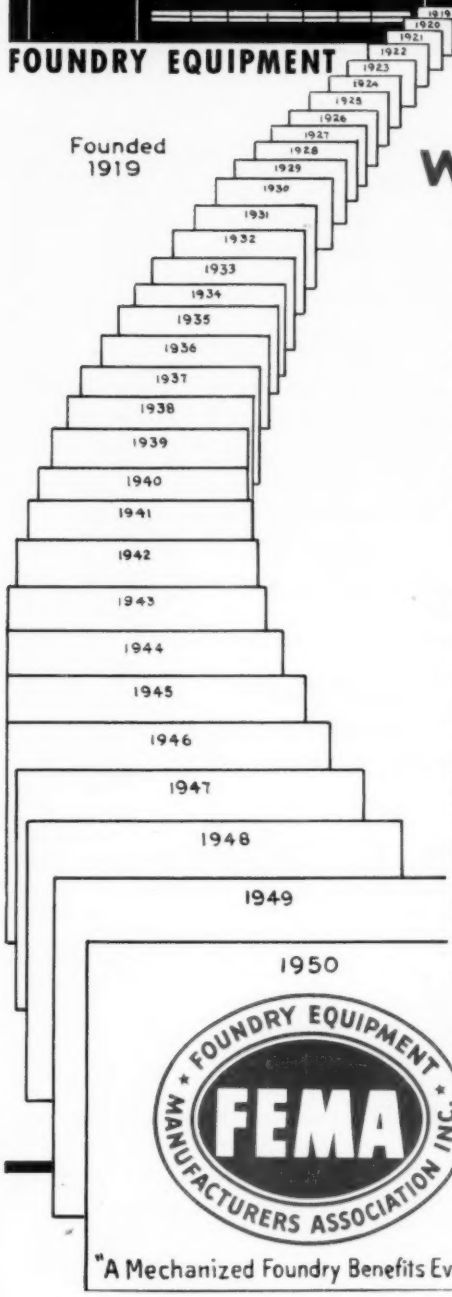
Then make a note on your calendar to check the status of your Payroll Savings Plan six months from today—and you will be surprised and gratified at the high percentage of employee participation you will find.

The U. S. Government does not pay for this advertising. The Treasury Department thanks, for their patriotic donation, the G. M. Basford Company and

American Foundryman



FOUNDRY EQUIPMENT MANUFACTURERS ASSOCIATION, INC.



What F. E. M. A. does for the Foundry Industry

- Fosters member co-operation
- Improves trade relations
- Promotes industry recognition
- Stimulates foundry research
- Disseminates progress reports
- Co-operates with allied organizations
- Compiles trade information
- Stimulates better foundry equipment

MEMBERSHIP ROSTER

Ajax Flexible Coupling Co. Inc.
Allis-Chalmers Manufacturing Company
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American Air Filter Co. Inc.
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Arcade Manufacturing Co., Div. of Rockwell Manufacturing Co.
Baker Perkins Incorporated
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Buell Engineering Company, Inc.
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Cleveland Metal Abrasive Company
The Conover Engineering Company
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Iron Lung Ventilator Company
The Jeffrey Manufacturing Company
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The MacLeod Company
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Newaygo Engineering Company
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Wadsworth Equipment Company
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Address:

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Cleveland 14, Ohio

FOUNDRY EQUIPMENT MANUFACTURERS ASSOCIATION INC.
FEMA

"A Mechanized Foundry Benefits Everyone"

A Mark of Product Reliability fostered through progressive group activity and leadership in serving the foundry industry

Calling All Core-Makers...

KRAUSE CEREAL BINDERS HELP YOU TO GET FINER CORES AND CASTINGS IN 4 WAYS

1 **GET MORE GREEN STRENGTH**

2 **IMPROVE FLOWABILITY AND TEXTURE**

3 **PRODUCE FINER DETAIL**

4 **GET EASY BURN-OUT, COLLAPSIBILITY**

Krause Cereal Binders are made under time-tested formulas — their uniform quality is laboratory controlled.

Get the binder advantages you need and want — specify TRUSCOR if you like light weight; AMERIKOR if you prefer the heavy weight. Order from the distributors listed below or direct from us.

CHAS. A. KRAUSE MILLING CO., Milwaukee 1, Wis. • *World's Largest Millers of Dry Corn*

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166 Brewery Street
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Western Industrial Supply Co.
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Portland 14, Oregon

HERE'S HOW...

CHICAGO TRANSIT AUTHORITY CUTS MELTING TIME IN HALF

. . . cuts fuel cost 50% . . . cuts metal losses 40%

Chicago Transit Authority, one of the world's largest transportation systems, operating 2,400 streetcars, 1,625 elevated cars, and 1,100 buses, installed a Fisher oil fired Simplex Melting Furnace for remelting, reclaiming scrap, brass, and bronze. Journal and axle bearing brasses and worn parts from all types of rolling stock are melted down and recast into new parts.

The new Fisher Simplex replaces a conventional oil fired spherical type open flame furnace. Check this "Before and After" story of faster melting, lower fuel cost, and lower metal losses.

	BEFORE	AFTER
Heating time 1000 lb. charge	2½ hrs.	1 hr.
Fuel cost per pound melted	$.0036	$.0027
Metal Loss	5%	3%

Ask for bulletin #28-A "Fisher Simplex Furnaces."

FISHER ADVANTAGES

Furnace charges *easily* from front at convenient height. . . . More scrap can be charged because of large area above molten metal line. . . . Uses open flame reverberatory melting, the *fastest* fuel fired melting method. . . . Two section furnace shell removable for *easy* relining.

Fisher Furnaces

A DIVISION OF LINDBERG ENGINEERING CO.
2440 West Hubbard Street, Chicago 12, Illinois

Improving Machinability of GRAY IRON CASTINGS

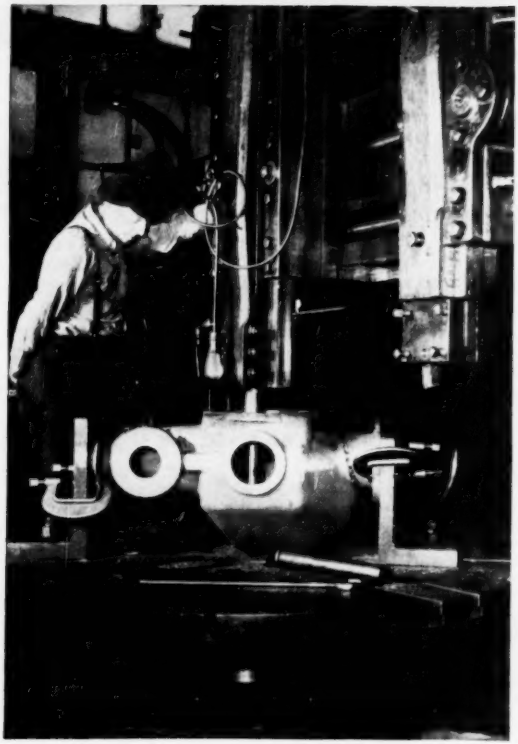
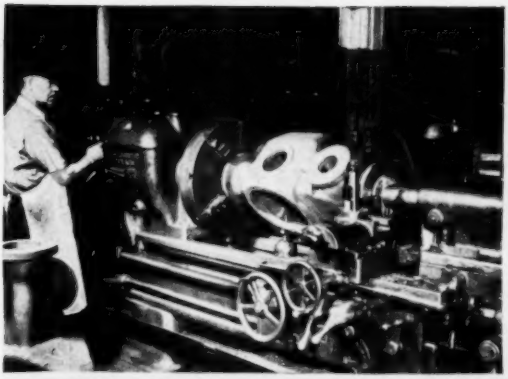
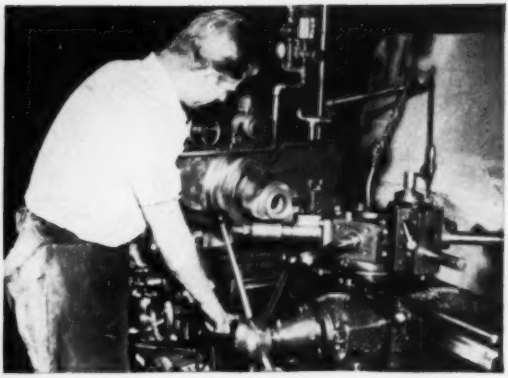


Photo Credit: Photos showing machining of castings, which have been treated with FERROCARBO Briquettes, are by the courtesy of the Rockwell Manufacturing Company, Pittsburgh, Pa. Castings were produced at Monnessen Foundry, a division of Rockwell.





3 IMPORTANT ADVANTAGES

to castings poured from iron which has been deoxidized with FERROCARBO silicon carbide Briquettes are:

1. Reduced machining time
2. Lower tool costs
3. Fewer rejected castings

The net result is realized in lower machining costs and increased profits. Complete detailed information on FERROCARBO Briquettes is easily obtainable from our metallurgical staff.

FERROCARBO Briquettes

BY CARBORUNDUM

TRADE MARK

THE CARBORUNDUM COMPANY, Bonded Products and Abrasive Grain Division, Niagara Falls, New York

FERROCARBO Distributors: KERCHNER, MARSHALL & CO., PITTSBURGH, Cleveland, Birmingham, Philadelphia and Buffalo; MILLER AND COMPANY, CHICAGO, St. Louis and Cincinnati; WILLIAMS AND WILSON, TORONTO, Montreal and Windsor.

"Carborundum" and "Ferrocarbo" are registered trademarks which indicate manufacture by The Carborundum Company

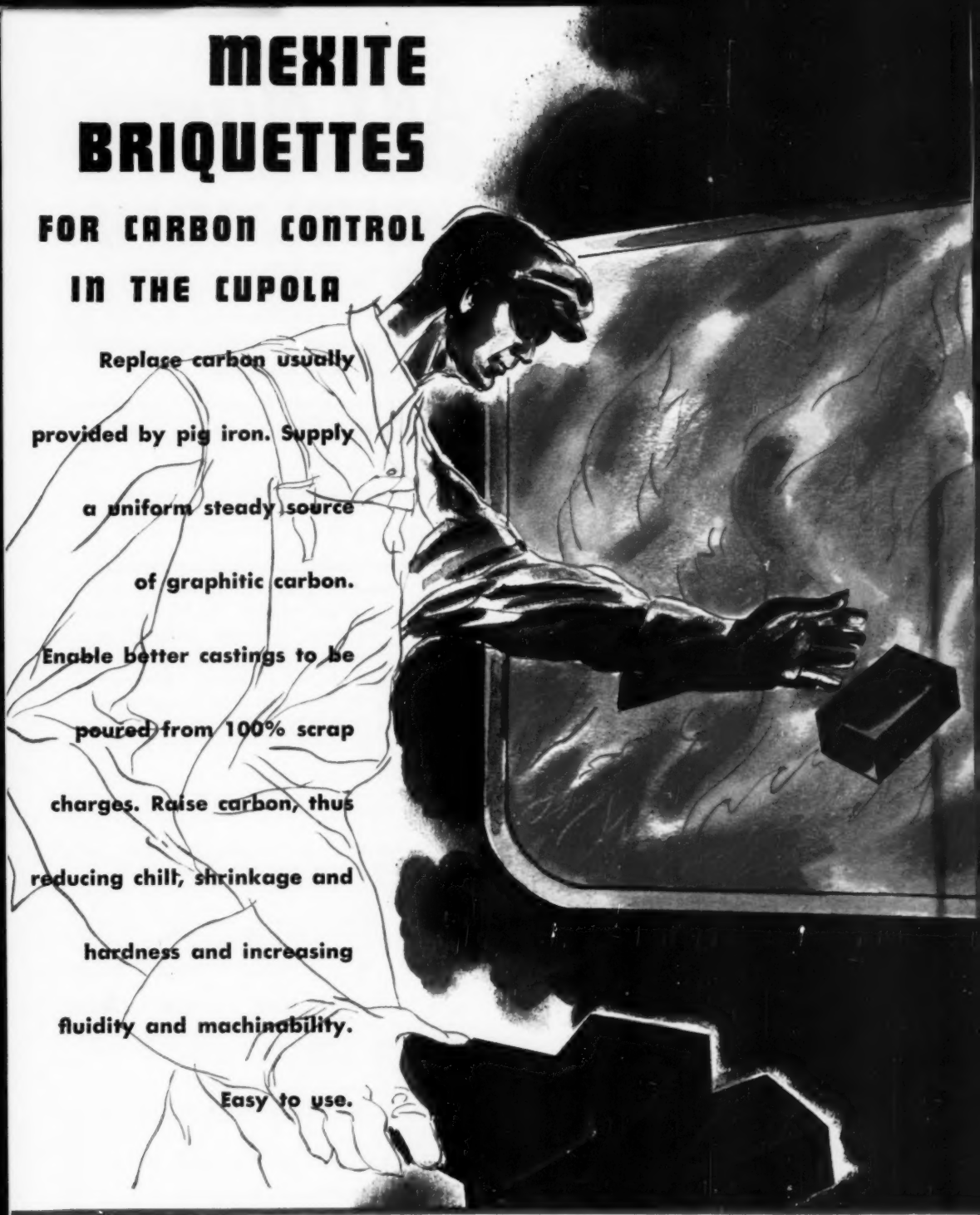
KEOKUK ELECTRO-METALS COMPANY Keokuk, Iowa • *Wenatchee Division:* Wenatchee, Washington

SALES AGENTS: Miller and Company
332 S. Michigan Avenue, Chicago 4, Illinois • 3504 Carew Tower, Cincinnati 2, Ohio • 407 N. Eighth Street, St. Louis 1, Missouri

MEXITE BRIQUETTES

FOR CARBON CONTROL IN THE CUPOLA

Replace carbon usually provided by pig iron. Supply a uniform steady source of graphitic carbon. Enable better castings to be poured from 100% scrap charges. Raise carbon, thus reducing chill, shrinkage and hardness and increasing fluidity and machinability. Easy to use.

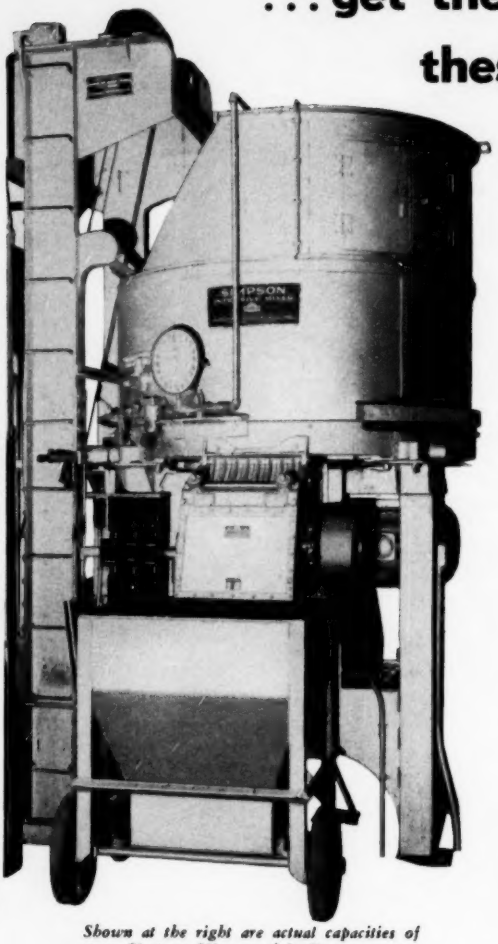


THE UNITED STATES GRAPHITE COMPANY

Division of The Wickes Corporation • Saginaw, Michigan

Before you buy ANY Mixer...

...get the answers to these QUESTIONS:



Shown at the right are actual capacities of some Simpson Mixer models. For more complete data, ask to have a National Engineer present additional facts and figures. Call or write today.

- What is the *actual* batch size in *pounds* that the mixer will handle on a daily production basis without overloading?
- How many tons of *properly prepared* sand will the mixer produce per hour, per day?
- How much horsepower is required *per ton* of *properly prepared* sand?

UNDER today's conditions, the answers to these important questions are more vital to *efficient* and *profitable* foundry operation than ever before. When you use SIMPSON Intensive Mixers, you'll find that the answers are on the *plus* side . . . with more productive capacity, lower initial cost, and less operating cost . . . based on actual operating data secured on the job in hundreds of foundries all over the country.

POUNDS PER HOUR OF PROPERLY PREPARED SAND WITH SIMPSON INTENSIVE MIXERS

SIMPSON MIXER MODEL	MAX. HORSE-POWER	BATCH SIZE IN POUNDS	2 MINUTE CYCLE	3 MINUTE CYCLE
No. 2	20	1,500	45,000	30,000
No. 3	50	3,000	90,000	60,000

Complete details on capacities of other Simpson Mixer models will be furnished on request

SIMPSON Intensive MIXERS

NATIONAL *Engineering Company*

600 Machinery Hall Bldg. • Chicago 6, Illinois

Manufacturers and Selling Agents for Continental European Countries—The George Fischer Steel & Iron Works, Schaffhausen, Switzerland. For the British Possessions, Excluding Canada and Australia—August's Limited, Halifax, England. For Canada—Dominion Engineering Co., Ltd., Montreal, Canada. For Australia and New Zealand—Gibson, Battle & Co., Pty., Ltd., Sydney, Australia

TRAIN TOMORROW'S FOUNDRYMEN TODAY

SECURING and training foundrymen for tomorrow's casting industry supervision and production needs has long been a problem. The situation is the same in other industries which, like the foundry, are not so well known though no less glamorous, interesting, and profitable than electronics, jet-propulsion, atomic energy, and others which have caught the public fancy.

With employment and production demands already high, a solution to the foundry personnel problem might appear to be even farther away as foundrymen anticipate the even greater production requirements which seem imminent. However, the foundry industry has taken a step in the right direction by working with the Foundry Educational Foundation in developing one of the sources of supervisory personnel—the engineering college student. Carrying out on an industry-wide scale what some schools and plants have practiced locally, the Foundation is rounding out its first three-year cycle of a dual program. One part of the program calls for assisting in the development of special combinations of courses and improvement in laboratory facilities in engineering colleges. Starting with seven schools, FEF expanded its activities to include 12 during 1950. Scholarships based on money contributed by the foundry industry have been set up in each of these schools.

A second phase of the program calls for placing the FEF scholarship students, and other college students who are interested, in foundries during the summer to get the actual work experience so valuable to the well-rounded foundryman.

This is an especially significant part of FEF's program to develop better equipped graduates for future foundry positions. (See page 58, this issue).

Our experience shows that, given the opportunity, students eagerly seek to gain knowledge of the foundry industry through summer work programs. They are fully aware that book learning needs to be supplemented by as many on-the-job experiences as possible.

Young men on vacation time work programs should be encouraged to become acquainted with all fields that interest them during their stay in the foundry. Questions should be answered freely and as completely as possible, even though they do not apply to the specific job on which the student is working.

In foundry management and operation, all types of problems arise daily in molding, coremaking, melting, maintenance, materials handling, engineering and labor relations. Many of these problems can only be highlighted in a man's mind by actual contact with them in the field. Such contact, under a properly guided summer work program, can imprint forever on a student's mind the picture of managerial duties.

Even though a summer work student does not look to the foundry industry for a career, he will still develop an industrial approach of value to him. He can develop into a permanent friend of castings and the foundry industry. If he becomes a foundryman after graduation, he becomes part of the answer to management's problem of filling supervisory openings resulting from normal turnover, and the more serious problem of developing an expanding staff to cope with greater production demands.

F. C. RIECKS
Cleveland Foundry Project Engineer
FORD MOTOR CO.

Manager of foundry operations for the Ford Motor Co., Dearborn, Mich., from 1947 until named Cleveland Foundry project engineer recently, F. C. Riecks has an international reputation as a foundry design and construction engineer. He joined Ford in the fall of 1916 as a power plant draftsman after graduating as a mechanical engineer from the University of Michigan earlier that year. Since then, he has worked for tillery and later in the air corps. Mr. Riecks' activities in various Ford plants and departments have ac- Ford in this country and abroad with the exception of a period in World War I when he was in the ar- quainted him closely with maintenance and construction, accounting, and plant engineering and design, not only in connection with foundry operations but also with open hearth, steel mill, glass plant, and forge plant operations. His overseas Ford assignments included work in China, Japan, and France. He designed and constructed many World War II projects for his company. A former American Foundrymen's Society National Director, he is a trustee-at-large of the Foundry Educational Foundation.

to be host to

FOUNDRYMEN OF MANY NATIONS

INTERNATIONAL FOUNDRY CONGRESS

Atlantic City, N. J. May, 1952

INTERNATIONAL TRADE, free exchange of ideas, and world brotherhood of men with a common interest—the art of casting metals—will be highlighted at the 1952 International Foundry Congress, when the American Foundrymen's Society will be host to foundrymen of the world at Atlantic City, N. J.

Held in conjunction with the Congress will be the biennial A.F.S. Foundry Show, at which manufacturers of foundry equipment and supplies and foundry service organizations will exhibit wares that embody latest developments in aids to the art of casting metals to foundrymen of many nations.

International Exchange of Technology

Technical program of the International Foundry Congress will stress free interchange of ideas between foundrymen of the world to their mutual benefit and the advancement of the castings industry. Scheduled are technical meetings, round table luncheons, dinner meetings, and the popular evening Shop Courses, that will afford overseas visitors an opportunity to acquaint themselves with the more practical aspects of foundry technology as applied to the castings industry.

Internationally-prominent foundrymen will speak on up-to-date developments in foundry technology. Round tables, panels and open discussions on the casting of gray iron, steel and non-ferrous metals and on sand technology, patternmaking and many other segments of the castings industry will give each foundryman the opportunity to contribute to the industry's technology. In turn, he will benefit from the free give-and-take of knowledge between foundrymen from all over the world.

Atlantic City's eight-mile-long Boardwalk, with its attractive shops, theaters, and restaurants, has long been one of America's premier year-round resort attractions.

Plan 28-Day Tour for Overseas Visitors

Plans are already under way for extensive visits to foundries on the Eastern Seaboard. For overseas visitors, a 28-day tour of Eastern and Midwestern foundries is contemplated. This tour will include the week-long International Foundry Congress and will feature visits to all types of foundries, pattern shops, and related industrial plants. Tentatively scheduled for the tour are foundries in New York, Cleveland, Cincinnati, Philadelphia, Detroit, Birmingham, Pittsburgh, Chicago, Buffalo, and Milwaukee. Prominent foundrymen in each of these cities will act as hosts to the visitors.

Sandwiched between foundry visits on the tour will be trips through such world-renowned industrial and commercial enterprises as the Chicago Stock Yards, Detroit-area automotive industries, and the Gary, Ind., steel mills.

Offering international visitors moments of relaxation on the heavily-scheduled tour will be the scenic and historic attractions of Washington, D. C., with its Capitol, White House, Washington Monument, Lincoln Memorial, and Smithsonian Institute, and near-by Mount Vernon and Arlington National Cemetery; New York's Radio City, Statue of Liberty, and United Nations and Empire State buildings; historic Philadelphia and Valley Forge; and Chicago's famed Lakefront, home of the A.F.S. National Office, and the Museum of Science and Industry.

Announce Congress Highlights

At the 1952 International Foundry Congress & Show, Convention highlights will include an International Reception for all foreign visitors, A.F.S. President's Reception for official delegates from foreign countries, the Annual Business Meeting of the American Foundrymen's Society, the Charles Edgar Hoyt Annual Lecture (featured technical address of the Congress), the A.F.S. Alumni Dinner (by invitation only), the An-

nual Banquet and entertainment, and current programs of visits to Atlantic City area foundries and Ladies' Entertainment.

Now in an early stage, plans for the 1952 Foundry Show include, in addition to displays of the world's leading manufacturers of foundry wares and services, exhibits of various Government agencies, trade and technical organizations, technical schools, and foundry educational organizations. Among the exhibits to be shown are the 1952 A.F.S. Apprentice Contest castings entries, that of the A.F.S. Patternmaking Division, international castings, trade and high school foundry work, educational aids to the foundry industry, and many others.

Auditorium Largest In World

Atlantic City's huge Convention Hall and Auditorium—largest anywhere—will house both technical activities and exhibits for the 1952 International Foundry Congress & Show. Main Hall of the Auditorium will house the exhibits. The ballroom of the Auditorium, which will accommodate 5,000 persons comfortably, will be the scene of major technical and business meetings. Numerous meeting rooms, each seating from 50 to 500 persons, will accommodate an additional 12,000 persons at one time.

Facilities for the huge Foundry Show that will run concurrently with the 1952 International Foundry Congress are unequalled both from the standpoint of the visitor and the exhibitor. Supported by the largest trusses in the world, the Main Hall has no pillars and thus offers an unimpeded view of the many displays. For the convenience of exhibitors, freight trains can be loaded at the entrances to the Hall and automobiles and trucks can easily be driven to any part of the building.

Housing Facilities Unexcelled

Housing facilities for those attending the 1952 International Foundry Congress will include world-famous luxury hotels, situated high above the Boardwalk and overlooking the Atlantic Ocean. Among these hotels, offering some 27,000 rooms are the world's largest resort hotel, and the world's tallest. Emphasis is placed by these hotels and by Atlantic City's many

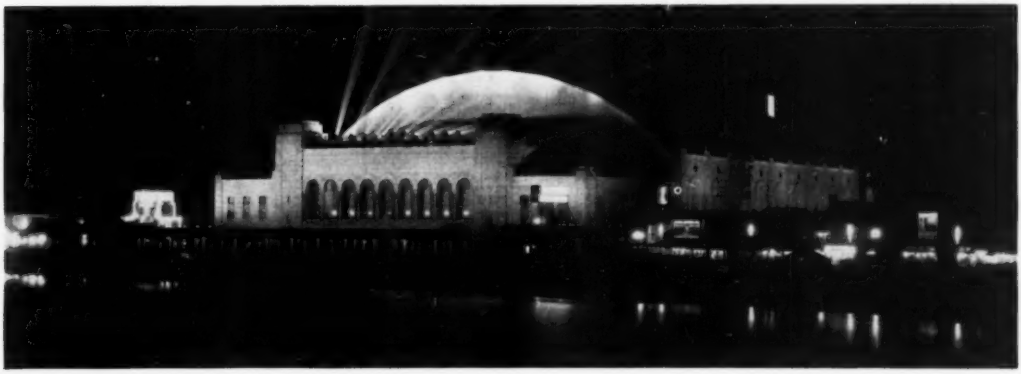
Some of Atlantic City's world-famous hostelries are shown in this sea-view of the beach and Boardwalk.

reasonably-priced tourist homes on providing the utmost comfort and relaxation for busy foundrymen during the closely-scheduled Congress.

For those Congress delegates who find themselves with free time between sessions during the day, Atlantic City offers many attractions. One of America's premier resorts, the city offers golf on four excellent courses, horseback riding, bicycling, or strolling along the famous Boardwalk, an eight-mile-long wooden beachside promenade. Ladies of the Foundry Congress, too, will find much to occupy their leisure moments and a week-long Ladies' Entertainment program will include receptions, teas, luncheons, a fashion show, entertainment, and visits to the sites of battles of the American War for Independence, beautiful state parks, bathing beaches, and other scenic and historical sites. Luxurious shops, fine restaurants, clubs and theaters line the Boardwalk and offer relaxation in the evening.

Thus the finest in convention meeting, exhibit, housing, social and recreational facilities will be combined in the 1952 International Foundry Congress, when foundrymen of America and their brothers-in-industry throughout the world will meet in the fulfilment of a common desire—betterment of the castings industry for the ultimate good of mankind.

Night view of Atlantic City Convention Hall and Auditorium, site of 1952 International Foundry Congress.



THREE-MINUTE QUALITY TEST for 85-5-5-5 RED BRASS

Report of the A.F.S. Brass & Bronze Research Committee

QUICK AND RELIABLE quality test for 85-5-5-5 red brass has been developed by the A.F.S. Brass and Bronze Division's Research Project on Fracture Test as an Index of Melt Quality, currently being carried out at the University of Michigan. The procedure outlined below requires only three minutes and represents the results of some 70 heats and is considered by the Brass & Bronze Division's Research Committee to be the best practice at present. However, this procedure may be revised after further information is available.

Procedure

1. Set up chill block core and chill plate assembly as shown in Fig. 1. It is essential that the surface of the chill plate be clean and dry. This surface may be prepared by the use of an oxyacetylene torch which can first be used to heat the chiller, then to blacken it. A "bleed" slot must be provided in the core to lower the level of the metal in the mold and prevent chilling the upper face against the pouring basin. The hacksaw blade is inserted in the core prior to baking. The blade produces a notch effect in the chilled casting and provides a point that may be fractured. Any commercial core mix can be used with safety.

2. Superheat the melt to its final peak temperature, making additions for deoxidation and zinc loss according to standard shop practice.

3. Then, using a hot No. 2 crucible, tap the full volume of the crucible, which is approximately four lbs. With pit furnaces, the No. 2 crucible may be used as a ladle.

4. Immediately pour the chill block, making certain that the pouring temperature is between 2200 and 2000 F. The pouring basin must be kept full to insure a rapid, uniform rate of pouring.

5. The pouring basin is removed and the chill block is allowed to cool in the mold until the top has solidified, which requires 1 to 1½ minutes, depending on

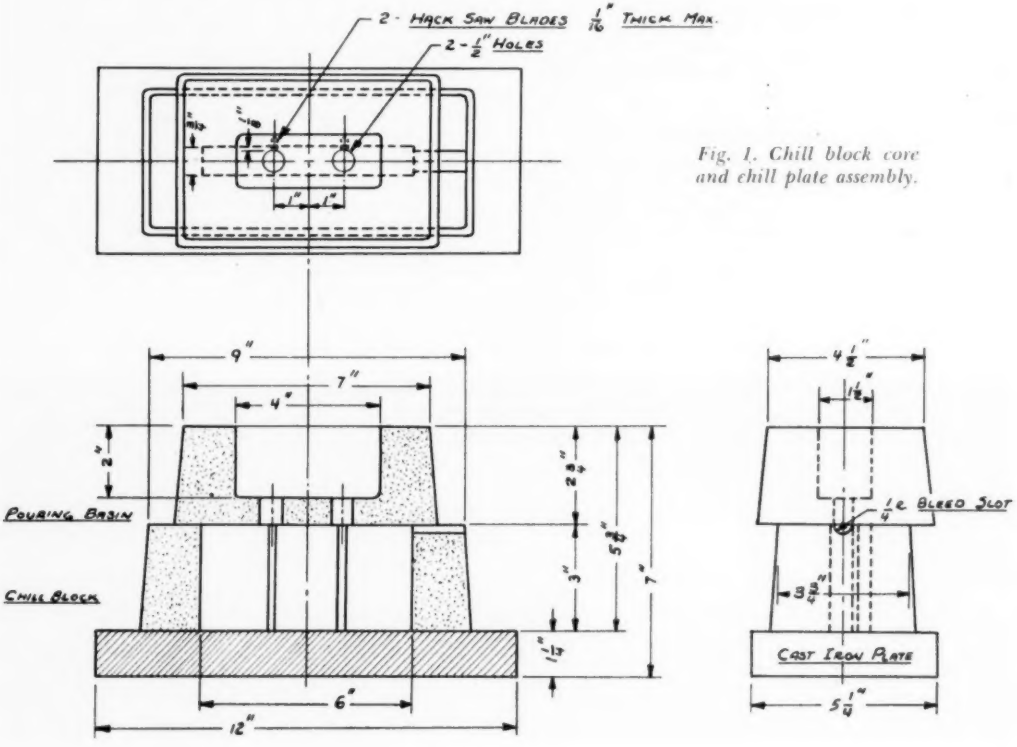


Fig. 1. Chill block core and chill plate assembly.

the pouring temperature. The block is then shaken out of the mold and water quenched.

6. After the chill block has been quenched, it is fractured in a fixture as shown in Fig. 2.

7. Fracture is examined, checked for melt quality.

Interpretation of Fractures

Fractures of chill blocks cast for quality control of red brass should be examined for each of several characteristics which are reliable indications of melt quality. The fractured surfaces consist of several distinct areas, all of which have some significance in evaluating melt quality.

1. Depth of Blue-Gray Structure: The most reliable index of melt quality, and one which can be evaluated quickly, is the depth of fine blue-gray structure which

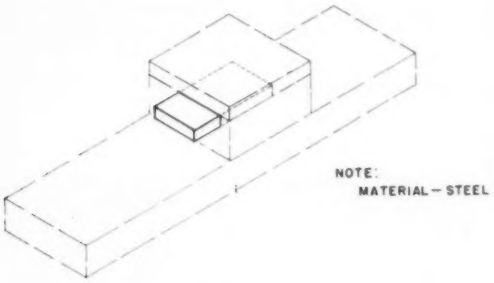


FIG. 2

SKETCH OF FRACTURING FIXTURE

originates at the chilled face and extends upward toward the air cooled face. This area has a smooth appearance and is separated quite distinctly from the coarser, reddish area above it. Tests at the University of Michigan have indicated that:

a. Melts of high quality (37,000 psi min. tensile strength and 30 per cent min. elongation) will show 2 in. or more fine blue-gray in the chill block fracture.

b. Melts of intermediate quality (25 to 30 per cent elongation) will show 1½ to 2 in. blue-gray structure.

c. Melts of low quality (less than 25 per cent elongation) will show less than 1½ in. blue-gray structure.

2. Texture of Fracture: Examination of the over-all texture of the fracture will provide a reliable indication of melt quality. The fracture may appear generally fine grained and smooth, which indicates high melt quality, or it may be coarse and granular with an over-all rough appearance, which indicates low melt quality.

Variations in fracture texture are controlled by the extent of blue-gray area and can, therefore, be related back to the depth of blue-gray. However, a check for fracture texture does provide a confirming indication of melt quality.

3. Color of Fracture: The color of a fresh 85-5-5-5 fracture provides a reliable index of melt quality. Fractures from melts of high quality have a definite blue color, far removed from the typical reddish color of the polished or ground surfaces. Melts of low quality have a reddish or coppery hue. Intermediate quality provides intermediate color indications.

4. Characteristics of Granular Area Above Blue-Gray: The extent of the rather coarse granular area above the blue-gray area in the chill block is an indication of melt quality. A small granular area indicates high quality; a large area, low quality. In general, the larger this area, the coarser it appears.

In metal of high quality, this area is reddish and finely granular. There is a slight indication of mottle, with fine flecks of yellowish material in the otherwise reddish fracture.

Fractures from low melt quality melts are coarser and more granular in this area, and have a characteristic mottled appearance. Melts produced in a gas fired furnace under reducing atmospheres show coarse yellow-gold mottle in the reddish background. Melts gassed by late contact with a source of water vapor are also mottled, but have a yellow-white mottle in the reddish background.

5. Columnarity: A columnar pattern, which originates at the chilled face and extends upward in the blue-gray area, may be used as an indication of melt quality. However, the depth of columnar pattern is influenced by pouring temperature, and this structure can be used reliably, only if the chilled block is poured at 2000-2200 F.

Assuming that the chilled block is poured at a temperature within the range of 2000-2200 F, the following depths of columnar pattern correlate with melt quality:

a. High melt quality shows ¾ in. or more columnar pattern.

b. Intermediate melt quality shows ½-¾ in. columnar pattern.

c. Low melt quality shows less than ½ in. columnar pattern.

6. Check on Production Practice for Chilled Blocks: Each fractured chilled block should be examined for indications of improper production practice which might provide false fracture characteristics. It has been found that any of several divergences from the specified practice might exert a strong influence on the fracture appearance. Some of these are:

a. Pouring Temperature—Pouring the chilled blocks at temperatures below 2000 F often produces false fracture appearance, principally in the lower level of the fracture. Blocks poured at the lower temperature do not exhibit a columnar pattern, and the blue-gray area is somewhat coarser than in blocks poured at 2200 to 2000 F. Further, the upper face of the fracture often has spongy brown areas where air is drawn into the bar during solidification.

When either absence of columnarity or the presence of spongy brown areas is encountered, the fracture should be viewed with skepticism lest false melt quality be concluded.

b. Gas Pick-up from Chiller or Notch—All chilled blocks should be examined for evidence of surface blows due to gas pick-up from the bottom chill plate or from the metal strip used for notching. Inadequate cleaning and drying of these metal parts may cause gassing, which can be detected by the presence of smooth, shiny blows on the surface or in the fracture. Obviously, this indicates gassing of the metal after pouring, and the fracture bar can only show lower than the true melt quality.

c. Chilling by Pouring Basin—The top surface of

blocks, in which the upper face is air cooled, is rounded and free from contact with the pouring basin. This is a necessity if true melt quality is to be measured from the fracture. Bars chilled on the top face by the basin are flattened, and the fractures show a considerable concentration of gas. The fracture is difficult to interpret in such bars, and the indications are unreliable.

d. Excessively High Quenching Temperature—The fractures of blocks quenched from the mold at excessively high temperatures may provide unreliable quality indications. Some may show fine fractures in the upper face, which should be granular, when made under standard conditions. This is due to quenching before complete solidification. Generally, the operator will detect these bars because of crumbling.

Bars quenched from below the solidification temperature, but above 1200 F may have quench cracks in the columnar area. These occur as smooth, brown areas in the fracture. These quench cracks coincide with the actual columnar zone and make no significant change in fracture indications.

Users Requested To Report Findings

The A.F.S. Brass & Bronze Research Committee, under whose direction the project at the University of Michigan is being carried out, requests that any foundry using the foregoing quality test for 85-5-5-5 red brass report its findings to the Technical Director, American Foundrymen's Society, 616 South Michigan Ave., Chicago 5, Ill. Results of these on-the-job tests in foundries will be of value to the Committee and to the Research Project's staff at the University of Michigan in making possible revisions in the procedure described in this article.

Headed by Blake M. Loring, Naval Research Laboratory, Washington, D. C., the A.F.S. Brass & Bronze Division's Research Committee, sponsor of the project at the University of Michigan, consists of A. H. Hesse, R. Lavin & Sons, Inc., Chicago; Gordon J. LeBrasse, Federal Mogul Corp., Ann Arbor, Mich.; C. A. Robeck, Gibson & Kirk Co., Baltimore; and Austen J. Smith, Michigan State College.

Research Fellow Frederick M. Baker is undertaking the A.F.S. Brass & Bronze Division Research Project at the University of Michigan, under the supervision of Professors W. P. Wood, C. Upthegrove and F. B. Rote of the University's Department of Metal Processing and Chemical-Metallurgical Engineering.

Stevens Institute Offering Courses, Seminar On Prevention Of Corrosion

COOPERATING with the National Association of Corrosion engineers, the Graduate School of Stevens Institute of Technology, Hoboken, N. J., is offering two courses and a seminar on the corrosion of metals. Designed for chemists, metallurgists, engineers and manufacturers, courses are already underway, with the first course beginning on September 27. This course covers fundamental factors and theories of corrosion, beginning with physical chemistry.

In the second course, beginning in February, methods of corrosion prevention will be studied in class, followed by weekly talks by 15 guest lecturers who are experts in their respective fields.

THE A.F.S. BUILDING FUND

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GOAL JUNE 30 1953

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PLEDGED Sept. 30, 1950

A PROJECT OF THE A.F.S. MEMBERSHIP

Special
INVESTMENT CASTING
Techniques

K. J. Yonker and G. A. Stolze
Precision Casting Section
Allis-Chalmers Mfg. Co.
Milwaukee, Wis.

PRECISON CASTING INDUSTRY has been confronted with many new production problems since investment casting proved itself an economical process for the production of parts previously manufactured by other methods. Such problems could be expected with a process that makes it possible to utilize designs and materials in the production of parts that cannot be manufactured by any other method.

As investment casting became more widely known, many new industries availed themselves of this new production tool. Casting manufacturers had to consider new design, larger castings, and the ability to handle a wider range of alloys. Although fundamentals of the process remain unchanged, many minor variations are necessary to produce good castings. These modifications, or techniques, had to be employed through all steps in casting manufacture from injection of the wax pattern to pouring of castings.

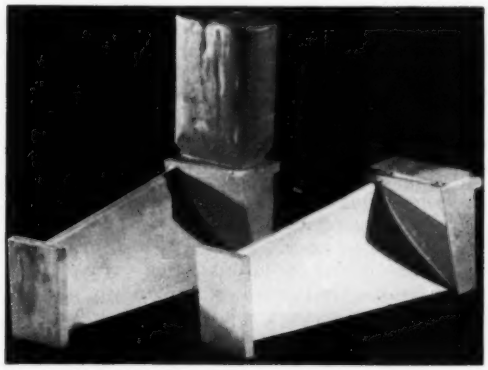


Fig. 1. Six-lb precision-cast Cr-Ni-Co alloy cylinder blade, requiring special pre-coating and gating processes.

Constructing Dies

In early investment casting practice, dies for wax injection were generally cast of non-shrinking tin bismuth alloys. However, many objections to this type of die were found. Maintenance costs were high, die life was relatively short, and often dimensional changes took place within the die cavity after repeated use. These conditions have gradually changed the method of die manufacture so that at present practically every new part being cast has a steel die for wax injection. These steel dies are machined from solid metal and are similar in design to dies used in plastic injection.

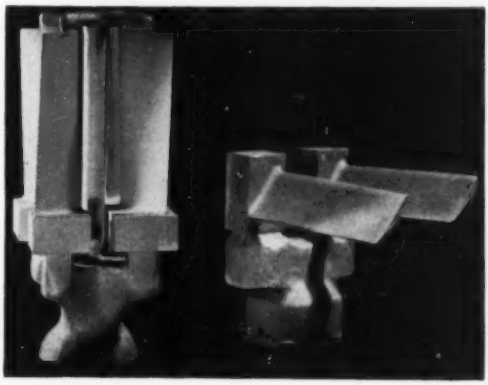
Today, many new pattern materials are available to the investment casting manufacturer, including new types of waxes, as well as plastics. It had been found necessary to use different injection materials for various applications. Some castings require a brittle, hard wax that cannot be deformed, whereas others may require a wax that softens at room temperature, making it easier to remove patterns from dies.

Type of pattern material used must be suitable to injection equipment available. Since the trend in precision casting is toward larger castings, it is often necessary to employ special precautions for filling heavy cross-sections within the injection die. This can be accomplished by either of three methods: (1) by placing a solid wax piece or a removable core within the heavy section in the cavity to reduce total shrinkage of the pattern; (2) by cooling the die in such a manner as to control solidification so it proceeds progressively toward the injection hole or causes all of the shrinkage to occur in the center of the pattern by first forming a hard skin; or (3) by maintaining pressure on wax for an extended period of time in order to feed the shrinking pattern.

Usually on each new casting, the phase of the process requiring most careful consideration is that of designing a suitable gating method. Since each casting is a problem in itself, gating is discussed more completely in the descriptions of specific applications.

Many new techniques have been developed in the pre-coating or dip-coating of the wax assembly pre-

Fig. 2. Vertical set-up was used to produce these 6-in.-long axial compressor blades. Multiple dips reduced surface defects and extra care in pouring was employed to insure filling-out of mold cavity.



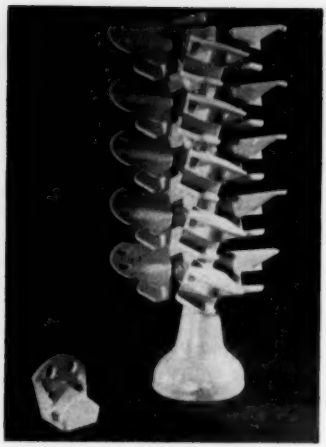
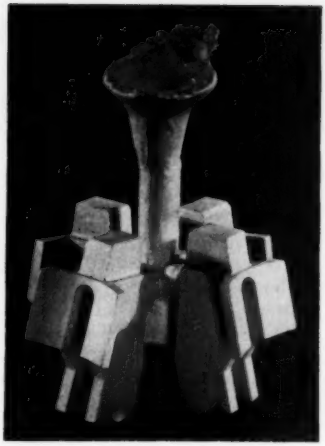


Fig. 3. Serrations of fine grooves in this assembly of bracket castings require careful positioning to obtain best pack during vibration. Cluster exemplifies proper positioning and gating for optimum pieces in mold.

Fig. 4. Support body casting required placing of cold wax chills in die cavity to hold pattern dimensions consistent. Time in the firing furnace had to be extended to volatilize all of the residual wax completely.

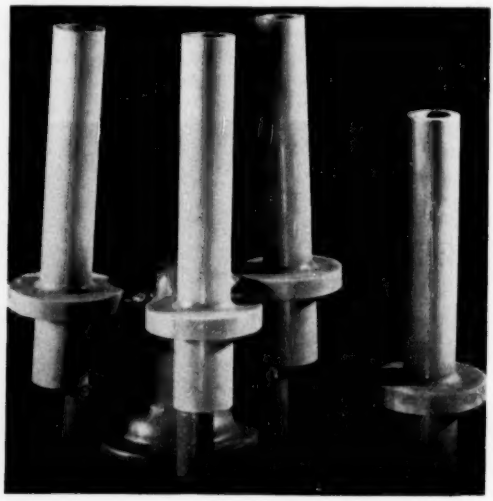


liminary to investing. Adherence of the pre-coat to the pattern material is important, especially on large, flat patterns. This can be somewhat improved by treating the pattern before application of the pre-coat, by roughening the pattern surface slightly, or by removing old oil or parting media and cleaning the pattern surface thoroughly.

The pattern contour will in some cases make it difficult to bond the pre-coat to the pattern surface properly, due to stresses set up in drying. These stresses can cause the pre-coat to pull away from the pattern and result in both dimensional discrepancies and severe surface defects in castings.

The application of refractory pre-coat to the wax assembly is ordinarily a simple problem, especially on small castings. On larger work casting defects can often be traced to pre-coat. Multiple dips, different dusting agents and partial pre-coating can be utilized along with adjustment of drying time to eliminate these defects.

Fig. 5. These austenitic stainless stem fitting castings required special strong investments in order to eliminate core failures. The ratio between the core diameter and the length was too great to withstand metal pressure when normal strength investments were used.



A better bond between pre-coat and secondary investment can be obtained by use of coarse dusting agents which will provide a better mechanical bond between the pre-coat and back-up investment. Use of multiple dips tend to give primary coating sufficient strength so that bonding of secondary investment over the entire area of the pattern is not important. If pre-coat is insufficiently dried before investing it will tend to soften and react with back-up material resulting in a wavy or buckled casting surface.

To produce large castings satisfactorily, development of new higher strength investments was imperative. Higher strength investments are now obtained by varying dry mixture as well as binders. Since a friable mold material is desirable for cleaning of castings after shake-out, the strength of investment should be limited to that necessary to produce satisfactory castings consistently, so that cleaning costs are not excessive. Cost of the investment increases, since binders of higher silica concentration are used.

In investing a mold, it is important that a good bond between pre-coat and secondary investment be obtained. In order to do this, pre-coat must be thoroughly wetted by liquid binder during the process of investing. Speed of pouring slurry into the flask is critical in this step of the process.

After investing slurry is poured into flask, the mold must be vibrated to obtain desired pack. Variation of the magnitude of vibration can be utilized in obtaining the proper pack for different set-ups.

Removal of wax from mold prior to firing is usually accomplished by two means. Low-pressure steam forced against the sprue and use of a de-wax oven are the two most commonly used methods. Although de-waxing in itself would seem to be a simple operation, mold failures often occur in this step of the process. Differential expansion between pattern

and investment material can cause mold failure. Cracking of the mold during de-waxing cycle may be caused by this expansion, but can usually be eliminated by the use of hollow wax sprues and gates, and by runner redesign.

Proper curing is dependent upon size of the mold, type of wax pattern used, rate of heating, and firing temperature. Generally, time of firing varies directly with size of mold. Elimination of residual pattern material during curing is effected by melting point, viscosity, and combustibility. Rapid heating will cause mold cracking. Improper burnout of expendable pattern may result in pitted surfaces, shrinkage, or porosity in castings. For this reason, firing temperature and time-at-temperature must be adequate.

Small Heats Present Melting Problems

Problems in casting molds are closely allied to those in the sand foundry. However, conventional small heats introduce such melting problems as control of chemical analysis, measurement of pouring temperature, and obtaining proper rate of melting. Analysis may be best controlled by use of master heats of the desired analysis, requiring little or no alloy additions during melting. In measuring the temperature of molten ferrous alloys, best results are obtained by using an optical pyrometer. However, the large variety of alloys and the small heats make consistent, accurate measurement difficult. Proper melting rate ceases to be a problem if uniformly sized melting stock is repetitively used.

Specific examples of the application of some newer techniques are described below. These are typical cases recently encountered in Allis-Chalmers investment casting production:

Figure 1 shows a 6-lb cylinder blade casting made of a chromium-nickel-cobalt high-temperature alloy. Suitable gating was developed to eliminate shrinkage and special techniques had to be used in pre-coating to produce a satisfactory airfoil. The casting was gated as shown and was positioned in the flask so that the outer shroud was within ¼ in. of the flask wall. This was done to promote progressive solidification, beginning at the blade tip. Prior to application

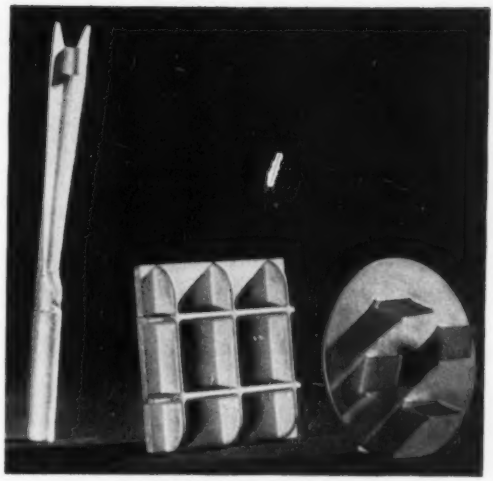
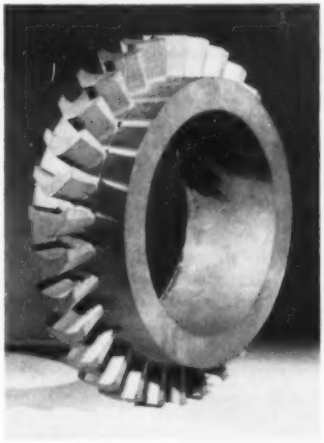


Fig. 6. Thin parts such as this core tube, cover and impeller require hard pattern waxes that will not deform in order to obtain flat surfaces in castings.

of the pre-coat, wax patterns were flash-dipped in a solvent to obtain proper adherence.

Multiple dips were used to strengthen the coating and to minimize local failures which would result in dirt in the casting. Face of mold around the sprue was painted with pre-coat to prevent fragments of investment loosened during the firing process from lodging in the mold cavity.

Axial compressor blades approximately 6 in. long (Fig. 2) are made of AISI type 420 stainless steel. X-ray sound castings, completely filled out along the trailing edge, were difficult to obtain because of the large volume of metal in the root section as compared to blade section. The horizontal set-up was tried first, but to get more pieces in a mold and to reduce x-ray shrinkage the vertical set-up was used. Surface defects due to dirt were reduced by use of multiple dips. Complete



Figs. 7 and 8. Two views of an 8-lb rotor disc casting requiring special precision investment casting techniques to eliminate shrinkage defects at base of blades. These included use of larger diameter flask and additional time-at-temperature during firing cycle to burn out wax.

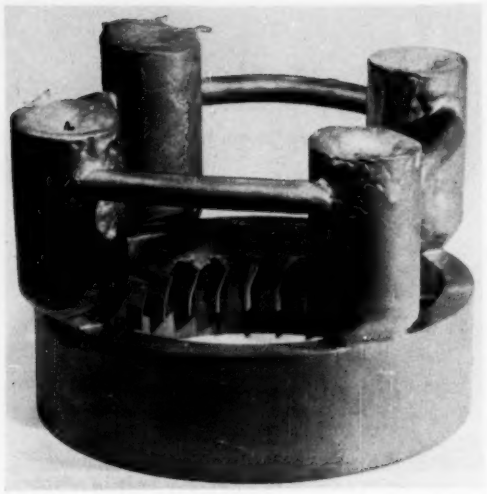


Fig. 9. Blades on inside of ring complicated casting of this stator disc. Special doughnut-shaped flask was used to start solidification at tip of blades. Inside concentric ring of the flask dissipated heat and effected cooling.

fillout of mold cavity required extra care during pouring. The stream of molten metal was directed at the center of the down sprue.

Bracket castings shown in Fig. 3 have serrations or fine grooves requiring careful positioning in assembly to obtain best pack during vibration. This casting cluster is a good example of proper positioning and gating to get the optimum number of pieces in a mold.

Support body casting (Fig. 4)—cold wax chills placed in the die cavity before injection were necessary to hold pattern dimensions consistently. Because of shape of this part, considerable wax was trapped within mold after de-waxing. As a result, time in firing furnace had to be extended to volatilize all the residual wax completely.

Special strong investments had to be used for austenitic stainless stem fitting castings shown in Fig. 5 to eliminate core failures. Although core is supported on both ends, the ratio between length and diameter is too great to withstand metal pressure with normal strength investments. A well-packed investment under the flanges was obtained by tilting mold during vibration.

Thin parts such as the core tube, cover and impeller shown in Fig. 6 require hard waxes that cannot be deformed to obtain flat surfaces in the casting. Even though straightening operations are common to obtain correct dimensions, often the alloys used are such that permanent dimensional corrections are difficult to attain.

Special techniques were used on an 8-lb rotor disc casting (Figs. 8 and 9) to eliminate shrinkage defects at the base of the blades. The design of the part is not conducive to good casting since individual blades are heavier at the tip than at the root. Shrinkage was controlled by using a flask of such diameter that the clearance between the tip of the blades and the flask face was only $\frac{1}{8}$-in. The time at temperature during the firing cycle had to be increased to burn out all wax completely, since residual wax can react with metal to form gases, which in turn can accentuate shrinkage tendencies.

Although blades on the stator disc shown in Fig. 9 are properly tapered for progressive solidification, they are on the inside of the ring rather than on the outside, complicating casting of this part. After pouring, a great deal of heat is concentrated on the inside of the ring. To start solidification at tip of the blades, a special doughnut-shaped flask was used. This flask was made of two concentric rings. Heat dissipated through the inside ring gave the desired cooling effect.

SFSA's Display Panels Bring Story Of Steel Casting Into Schoolrooms

NOVEL METHOD of carrying the story of the steel castings industry into lecture rooms of leading U. S. engineering schools has been developed by the Steel Founder's Society of America as part of its newly-expanded information services.

Portable display panels designed to convey basic information on steel castings to student and faculty groups are available on a loan basis to engineering schools. Dramatizing the subject by use of color, animation and illumination, the 4 x 6 ft panels operate electrically, flashing a series of sequential kodachrome pictures depicting steel casting applications selected to meet exacting engineering and design requirements.

Future Meetings and Exhibits

AMERICAN SOCIETY FOR METALS, national metal exposition and Congress, International Amphitheater, Chicago—Oct. 23-27.

NEW ENGLAND REGIONAL FOUNDRY CONFERENCE, New England Foundrymen's Society, Massachusetts Institute of Technology, Cambridge, Mass.—Oct. 27-28.

METALS CASTING CONFERENCE, A.F.S. Central Indiana and Michiana Chapters and Purdue University, at Purdue, West Lafayette, Ind.—Nov. 2-3.

NATIONAL FOUNDRY ASSOCIATION, annual meeting, Edgewater Beach Hotel, Chicago—Nov. 9-10.

STEEL FOUNDERS' SOCIETY, annual technical and operating conference, Carter Hotel, Cleveland—Nov. 9-11.

MICHIGAN REGIONAL FOUNDRY CONFERENCE, A.F.S. Detroit, Central Michigan, Saginaw Valley, and Western Michigan Chapters, Michigan State College Student Chapter, and Michigan State College, at East Lansing, Mich.—Nov. 10-11.

MALLEABLE FOUNDERS' SOCIETY, semi-annual meeting, Hotel Cleveland, Cleveland—Jan. 19, 1951.

WISCONSIN REGIONAL FOUNDRY CONFERENCE, sponsored by A.F.S. Wisconsin Chapter and University of Wisconsin, Schroeder Hotel, Milwaukee—Feb. 8-9, 1951.

A.I.M.E., annual meeting, Jefferson Hotel, St. Louis—Feb. 18-22, 1951.

BIRMINGHAM REGIONAL FOUNDRY CONFERENCE, sponsored by A.F.S. Birmingham District Chapter, Tutwiler Hotel, Birmingham, Ala.—Feb. 22-23, 1951.

OHIO REGIONAL FOUNDRY CONFERENCE, sponsored by A.F.S. Northeastern Ohio, Cincinnati District, Toledo, Canton District, Central Ohio, and Ohio State University Student Chapters, at Case Institute of Technology, Cleveland—Mar. 8-9, 1951.

55th Annual Foundry Congress, American Foundrymen's Society, Buffalo, N. Y.—Apr. 23-26, 1951.

HOLD NEW ENGLAND, PURDUE, MICHIGAN STATE REGIONAL MEETINGS DURING LATE AUTUMN

REGIONAL CONFERENCES in Cambridge, Mass., West Lafayette, Ind., and East Lansing, Mich., round out the 1950 series of interstate foundry meetings. The 10th New England Regional Foundry Conference, sponsored by the New England Foundrymen's Association and a host of other groups, will be held October 27 and 28 in Cambridge at Massachusetts Institute of Technology, one of the co-sponsors along with the MIT Student Chapter of A.F.S. Conference chairman is Frederick M. Fitzgerald, Draper Corp., Hopedale, Mass., with Thomas Curtin, Waltham Foundry Co., Waltham, Mass., as co-chairman.

The 3rd Annual Metals Casting Conference, sponsored jointly by Purdue University, and the Michiana and the Central Indiana Chapters of A.F.S., will again be held on the campus at West Lafayette. Dates are November 2 and 3. Chairman and co-chairman, respectively, are L. L. Andrus, American Wheelabrator and Equipment Corp., Mishawaka, Ind., and Prof. C. T. Marek of Purdue.

November 10 and 11 are the dates of the Michigan Regional Foundry Conference to be held on the Michigan State College campus at East Lansing. Sponsorship is by the college and the Detroit, Saginaw Valley, Central Michigan, Western Michigan, and MSC Student Chapters of A.F.S. Professors C. C. Sigerfoos and Austen J. Smith are co-chairmen.

New England Regional Foundry Conference

Program for the New England Regional Foundry Conference, arranged by Program Chairman Stanley Tims, Saco-Lowell Shops, Biddeford, Maine, includes sessions on costs, better methods, sand and molds, humanics, and cupola practice. Registration for the sessions outlined below will take place in the lobby of Building 10 on the MIT campus. Fee is $2.00. The conference dinner, scheduled for the evening of the first day, will be in the MIT Graduate House. After the conference the traditional smoker will take place in the evening on the Parker House Roof.

Friday, October 27

12:00 noon—REGISTRATION.
1:30 p.m.—ADDRESS OF WELCOME. Thomas K. Sherwood, dean of engineering, MIT.
2:00 p.m.—*"Foundry Costs,"* John L. Carter, Gray Iron Founders' Society.
3:00 p.m.—*"Better Methods Applied to Foundry Operations,"* Norman J. Henke, Central Foundry Div., General Motors Corp.
6:00 p.m.—CONFERENCE DINNER. *"Football as the Referee Sees It,"* Paul Swaffield.

Saturday, October 28

8:30 a.m.—REGISTRATION.
9:00 a.m.—*"Foundry Sand,"* Charles B. Schureman, Baroid Sales Div., National Lead Co., Chicago.
10:30 a.m.—*"Plastic Bonded Sand Molds,"* Bernard N. Ames, New York Naval Shipyard, Brooklyn, N. Y.
1:30 p.m.—*"Cupola Practice,"* T. E. Barlow, Eastern Clay Products, Inc., Jackson, Ohio.
3:00 p.m.—*"Humanics,"* Ralph L. Lee, General Motors Corp., Detroit.
Evening—SMOKER.

C. T. Marek

L. L. Andrus

Metals Casting Conference

In addition to the technical program announced for the Metals Casting Conference by Program Chairman Robert Spurgin III, Swayne, Robinson & Co., Richmond, Ind., this year's conference will have a new feature. Planned is an educational display of foundry products, accompanied by photographs taken in the industry, to demonstrate unique methods for the production of castings and solutions to design problems which have resulted in more profitable methods of production.

All sessions will be held in the Purdue Memorial Union Building which includes hotel room facilities. Rooms at the Union should be reserved as far in advance as possible.

Thursday, November 2

9:00 a.m.—REGISTRATION.
WELCOMING ADDRESS. Frank C. Hockema, vice president and executive dean, Purdue.
RESPONSE. Stowell C. Wasson, National Malleable & Steel Castings Co., Chicago.
11:00 a.m.—*"Recent Engineering Developments in the Foundry*

Paul Harlan (center), Electric Steel Castings Co., Indianapolis, Ind., and Professors R. W. Lindley and C. T. Marek (right), Metals Casting Conference regulars, watch Purdue University students conduct sand tests.

Industry," E. A. Canning, Allison-Bedford Div., General Motors Corp., Bedford, Ind.

1:30 p.m.—"*Good Casting Design—on Purpose!*" William T. Bean, Jr., Industrial Electronics, Inc., Detroit.

3:00 p.m.—"*Current Status of the Foundry Educational Foundation*," E. W. Horlebein, Gibson & Kirk, Co., Baltimore, Md.

6:30 p.m.—BANQUET. Speaker: L. P. Robinson, Archer-Daniels-Midland Co. (Werner G. Smith Co. Div.), Cleveland.

Friday, November 3

10:00 a.m.—"*Fluid Flow*," A.F.S. color-sound movie on Society-sponsored gating research. Commentary by Technical Director, S. C. Massari.

11:00 a.m.—"*Gating and Risering*," Norman A. Birch, American Brake Shoe Co., Meadville, Pa.

1:30 p.m.—"*Fundamentals of Foundry Sand*," Robert P. Schauss, Illinois Clay Products, Chicago.

A. J. Smith

C. C. Sigerfoos

Michigan Foundry Conference

Theme of the Michigan Regional Foundry Conference is "*New Trends in Foundry Development*." Sessions will be held in the MSC Union Building. Room reservations should be made directly with Lansing hotels. Advance registration for the conference can be addressed to: Michigan Foundry Conference, Special Courses and Conferences, Michigan State College, East Lansing, Mich. Registration fee for the entire program, including the Michigan State College-Minnesota football game is $10.00. Registration exclusive of the game and meals is $3.00.

Friday, November 10

8:30 a. m.—REGISTRATION.

9:15 a.m.—ADDRESS OF WELCOME. L. C. Price, head Mechanical Engineering Dept., Michigan State College, and Lorin G. Miller, dean, School of Engineering.

9:30 a.m.—"*Trends in Foundry Education*," B. D. Claffey, Acme Aluminum Alloys, Inc., Dayton, Ohio.

11:00 a.m.—"*Basic Cupola Operation and Practice*," Sam F. Carter, American Cast Iron Pipe Co., Birmingham, Ala.

12:00 noon—LUNCHEON.

2:00 p.m.—FOUNDRY AIR POLLUTION PANEL. Coordinator: Thaddeus Giszczak A.F.S. research metallurgist.

Meteorological—A. H. Eichmeier, U. S. Weather Bureau, East Lansing, Mich.

Plant Life and Pathology—Prof. Forrest Strong, MSC Department of Botany and Plant Pathology.

Public Health—K. E. Robinson, Michigan Department of Health, Lansing.

Testing Procedures—R. G. Smith, Bureau of Industrial Hygiene, Detroit.

Control Equipment—J. M. Kane, American Air Filter Co., Louisville, Ky.

Legal Obligations—Thaddeus Giszczak.

6:30 p.m.—BANQUET AND ENTERTAINMENT.

"*Activities of the American Foundrymen's Society*," National President Walton L. Woody.

"*Public and Industrial Relations in European Industry*," C. W. Otto, executive secretary, Lansing Chamber of Commerce.

Saturday, November 11

9:00 a.m.—"*Fluid Flow*," A.F.S. color-sound movie on Society-sponsored gating research. Commentary by Technical Director S. C. Massari.

10:00 a.m.—"*Progress Report on Foundry Research*," Prof. H. L. Womochel, MSC Mechanical Engineering Dept.

10:45 a.m.—"*Gating and Fluid Flow*," W. H. Johnson, Naval Research Laboratory, Washington, D. C.

2:00 p.m.—FOOTBALL. Michigan State College vs. Minnesota, Macklin Field Stadium.

A.F.S. Gray Iron And Steel Division Technical Committees Hold Meetings

TWO GRAY IRON and one Steel Division technical committees of the American Foundrymen's Society met with A.F.S. Technical Director S. C. Massari during recent months to formulate plans and programs.

Meeting June 26 at A.F.S. Headquarters in Chicago the Steel Division Research Committee, under the chairmanship of Clyde Wyman, Burnside Steel Foundry Co., Chicago, opened its agenda by deciding to continue the Division's Research Program currently underway at the Armour Research Foundation, Chicago. The program, it was decided, will emphasize (1) gating system, (2) pouring rate, (3) pouring metal temperatures, (4) obtaining data on the properties of sand at different temperatures at various distances from the casting sand interface, and (5) effect of wall thickness of core on production of hot tears.

Charles Locke of Armour Research Foundation reported that tests utilizing American Steel Foundries' test casting design have correlated well and that from eight heats of four test castings each, results from no hot tears to severe hot tears have been obtained. It was further suggested that sand temperature be measured at various depths from the casting sand interface and that a series of radiographs be taken by placing a radium pill in the center of the mold.

First of two Gray Iron Division Committee meetings was held by the Program & Papers Committee June 28 at A.F.S. Headquarters, Chicago, with Chairman W. W. Levi, Lynchburg Foundry Co., Lynchburg, Va., presiding. A.F.S. Technical Director S. C. Massari outlined the over-all program for the 1951 A.F.S. Convention, to be held in Buffalo, April 23-26. Tentative plans were made for the popular Gray Iron Shop Course and for technical session papers. These will include a Gray Iron Research progress report and papers on surface finish, chill tests, preheaters, European cupola practice, basic cupola operation, permanent mold foundry cupola operation, metallurgy and heat treatment of gray iron, and symposium on gating.

Gray Iron Research Committee, meeting at Massachusetts Institute of Technology, September 14 in conjunction with a two-day Symposium on Nodular Iron, reviewed research progress to date and planned a simplified presentation of the findings of this research. It was further decided to prepare a new and revised nomenclature of gating and risering.

MIT Research Metallurgist F. Brown outlined results to date of the A.F.S. Gray Iron Research Project in operation at MIT. He reported that examination of test castings obtained from cooperating foundries has been completed.

PRODUCING MALLEABLE CAST IRON

Basic Metallurgy and Operation Mechanisms

Leo R. Friedman
Plant Metallurgist
National Malleable & Steel Castings Co.
Cicero, Ill.

THEORETICALLY, THE METALLURGICAL PRINCIPLES involved in the production of malleable iron are simple, and the mechanism of the melting and malleablizing operations is not complicated. However, with increased machining speeds and longer tool life expected by the consumer, and higher production and faster anneal demanded by the producer, the metallurgical principles become more involved. Metallurgical details heretofore ignored must now be explored.

Simply, the manufacture of malleable iron consists of the melting of a charge composed mainly of pig iron, steel scrap and foundry returns to produce a white iron casting with all carbon in the combined form, and the subsequent malleablizing of this iron through heat treatment to produce a tough, ductile casting having a structure consisting of free iron and temper carbon without any combined carbon.

Melting Practice Affects Annealing

While these are two separate and distinct operations, the melting practice has a far-reaching effect on the annealing of the iron and its physical properties. Two batches of iron made at different times in the same melting unit with practically identical analysis can, and frequently do, exhibit radically different structures and physical properties, even when they are annealed together in a standard malleablizing cycle. In most cases this difference can be traced directly to some variation in the melting procedure or charge.

The malleablizing operation, on the other hand, if not properly handled can undo the best results of an efficient melting practice. However, with few exceptions it can not correct the damage done by a faulty melting practice without extending the cycle, sometimes to an impractical degree.

Regardless of whether the melting is done by a duplexing system or in a cold-melt air furnace, whether oil, powdered coal, coke, or electricity is used as fuel, the primary purpose is the same—production of a metal of predetermined chemical composition at a predetermined temperature.

The chemical composition and pouring temperature are determined by the size and design of the castings to be produced, the distance the iron must be carried, and the physical properties which must be met. Small castings of intricate design demand a metal of high fluidity. This can be obtained by high carbon and silicon contents, high temperature, or both.

High carbon iron has greater fluidity, greater machinability, and can be poured at a lower temperature than low carbon iron. In castings with heavier sections, high carbon iron becomes detrimental in that it has a greater tendency to produce primary graphite. High carbon iron also definitely produces lower physical properties than low carbon iron, other conditions being equal.

High silicon iron also has greater fluidity than low silicon iron and, since silicon is a graphitizing agent, it can be annealed in a shorter time. By the same token, it can produce primary graphite in a shorter time, and in moderately heavy sections. High silicon iron also is more susceptible to surface oxidation during annealing than low silicon iron.

Although malleable iron is principally an alloy of iron, carbon, and silicon, we cannot ignore the impurities which are always present in the charge materials. One of these is sulphur which, besides inhibiting the graphitization during annealing, will form around the grain boundaries as FeS and affect the physical properties adversely. To offset the harmful effects of sulphur, manganese is added to the iron in the approximate ratio of two times the sulphur content plus 0.10 per cent to combine it as MnS, forming harmless inclusions.

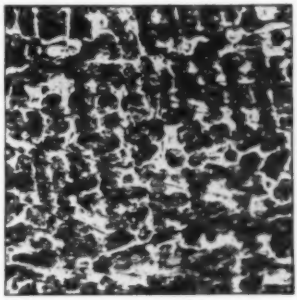


Fig. 1—White iron as-cast showing cementite in matrix of pearlite. All carbon combined. Etched. X100.

Phosphorus is also present in many of the charge materials, but in amounts of 0.100 to 0.180 per cent seems to be beneficial to the iron in that it increases fluidity and tensile strength.

While we are striving to stay within a specified chemical range, which we deem best for our own foundry practice, the chemical composition by itself is not a criterion of whether or not the iron is good. Charges high in graphitic material, especially in cupola melting, extend their influence into the molten metal and are more prone to mottle than charges lower in these constituents, even though the final analysis is in the same range.

Excessively rusty scrap, wet materials in the charge, or very light, thin scrap, all tend to contribute to a higher than normal oxidation loss, and if improperly adjusted to the correct analysis range, the metal will not respond to a normal annealing cycle.

NOTE: This paper was presented at the Wisconsin Regional Foundry Conference, sponsored by the A.F.S. Wisconsin Chapter and University of Wisconsin, at Milwaukee, Feb. 9-10, 1950.

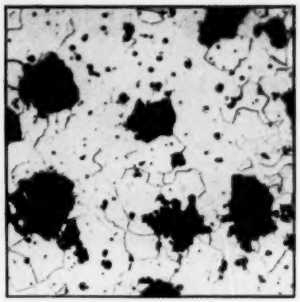


Fig. 2—Fully annealed malleable showing temper carbon in matrix of ferrite. All carbon as free temper carbon. Etched. X100.

Superheating also plays an important part in the mottling tendency of white iron. It has been found that iron which has been superheated at any time during the melting process is less apt to mottle, even with higher than normal silicon content. In this way it is possible to produce an iron which will anneal more rapidly without as much danger of mottling.

It is generally considered good practice to melt down with a charge high enough in carbon, silicon and manganese so that very little, if any, alloy additions are required at tapping time. Alloys added with the charge will not give as good recovery as when added to the bath but, by some mechanism not yet fully understood, they do impart properties to the metal that bath additions do not.

Perhaps the greatest improvements in the malleable iron industry have been in the annealing or malleablizing operations. This has been due mainly to the better understanding of the metallurgy of the anneal and the subsequent improvements in design of furnaces to take advantage of the known principles. Cycles which formerly were as long as 240 hr from firing time to firing time have now been cut to less than 60 hr, and in some special cases to 36 or 40 hr.

The transformation of white iron to malleable iron takes place in two stages. The critical range of white iron lies between temperatures of 1300 F and 1400 F; the iron undergoes a change in phase from alpha to gamma iron or austenite, which is formed from the pearlite. At this temperature the cementite remains unchanged and the structure of the iron consists of cementite in a matrix of austenite instead of pearlite.

Holding Temperature Range

As the temperature of the casting continues to increase the cementite becomes more soluble in austenite and some of it goes into solution. The higher the temperature, the faster the reaction takes place, and most annealing cycles use the range of 1650 to 1750 F as a holding temperature.

If the iron is held at 1700 F the austenite will dissolve all the cementite it can hold at this temperature and some of the carbon will be precipitated as free or temper carbon, the iron remaining as austenite. The austenite, at this point being undersaturated, can dissolve more carbon. As the carbon in the form of temper carbon is less soluble in austenite than carbon from cementite, more cementite will go into solution and be precipitated as free carbon until all the cementite is dissolved.

At this point the only carbon remaining in solution is that which the austenite will hold at the given temperature. If the iron is cooled rather rapidly to a temperature just above 1400 F, the amount of carbon in solution in austenite is approximately 0.9 per cent. At this point first stage graphitization is complete.

If the iron is removed from the furnace at the time the first stage of graphitization is said to be completed and cooled in air, the unstable austenite will revert to pearlite. The structure would then consist of temper carbon in a matrix of pearlite.

The second stage of graphitization consists of changing the austenite and the remaining carbon it holds in solution into free ferrite and temper carbon. When the temperature on cooling reaches the critical range, the cooling rate is slowed down to no faster than 10 degrees per hour, usually 5 degrees per hour. Here, the tendency of the austenite to revert to pearlite is retarded by the high silicon and slow rate of cool.

If the iron is cooled slowly enough at the exact critical temperature, the austenite will transform directly into ferrite and temper carbon. However, this is not always possible, nor can it be relied upon, and some pearlite will be formed while the iron is again changing phases—this time from gamma to alpha iron. The slow cool from 1400 F down spheroidizes the cementite in the pearlite, and given sufficient time it will decompose into free ferrite and temper carbon.

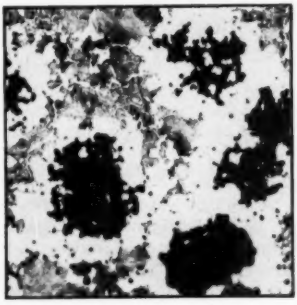


Fig. 3—Incomplete second stage anneal showing temper carbon produced in first stage of anneal, ferrite, and pearlite. Etched. X100.

When all the carbon is precipitated as temper carbon in a matrix of free ferrite, the second stage of graphitization is completed. Since no further changes will take place, the iron may now be removed and cooled at any rate desired without any harmful effects.

As previously stated, the melting practice and chemical composition have a great influence on the time necessary to complete the annealing cycle. Aside from this, however, there are many other factors which affect the annealing time.

In furnaces using an atmosphere to prevent scaling of the iron, the composition of the atmosphere has some effect on the annealing time.

Carbon Monoxide: The reaction of O_2 and CO_2 with the carbon in the iron in an airtight furnace will tend to create an atmosphere which may at times become as high as 70 per cent CO inside the furnace. This high percentage of CO has no effect on the first stage of graphitization. If the CO is diluted at the time the

second stage of graphitization is about to take place, the protection against scaling is maintained at the high temperature where it is needed and its harmful effects are not exerted on the second stage of graphitization of the iron.

Hydrogen: Many atmospheres created outside the furnace by the partial combustion of gas, oil, or gases which contain much water vapor, may carry with them considerable amounts of hydrogen. In amounts greater than approximately 10 per cent hydrogen has a retarding effect on the graphitization of white iron. In amounts less than 10 per cent, but probably over 5 per cent, the iron may be annealed in the regular cycle, but the ductility is adversely affected and the iron may break "short."

Other gases, such as CO_2 or N_2, do not seem to have any effect on the graphitization rate. Some common elements added to the regular white iron composition, either intentionally or as contaminants coming in with the steel scrap, also affect the annealing cycle time.

In general, all carbide-forming elements, such as Cr, Mo, etc., tend to retard or prevent the graphitization of white iron. Manganese, over and above the amount needed to form MnS with the sulphur present, will also retard graphitization, especially in the second stage. Manganese in amounts of approximately 0.80 per cent is used as an alloying element in the manufacture of some pearlitic irons.

Graphitizing Elements Shorten Cycle

All ferrite strengthening elements, such as Al, Zr, Ni, Cu, etc., tend to promote graphitization and shorten the time necessary to complete the annealing cycle. Aluminum and zirconium are such powerful graphitizers that even small amounts will promote primary graphitization, and must be used very cautiously if at all.

Another group of elements, among which are titanium, vanadium, and boron, acts to promote graphitization when used in amounts not exceeding a few hundredths of one per cent. In greater amounts they act as carbide stabilizers.

Phosphorus in amounts greater than 0.180 per cent, while not affecting the graphitization rate, may produce what is known as "white fracture," especially if in combination with high silicon. Depending on the rate of cool below approximately 1280 F, this iron may either be as ductile as normal malleable or brittle. When viewed under the microscope with the conventional nital etch, the iron appears to be perfectly normal. If this iron is reheated to a temperature around 1200 F and quenched in water, the fracture will revert back to normal black fracture. An excess of phosphorus also tends to raise the hardness of the metal slightly, with no apparent structural difference.

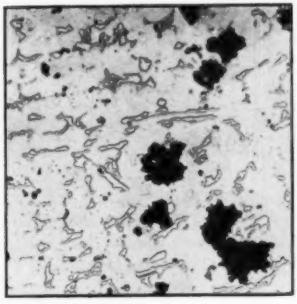


Fig. 4—Incomplete first stage anneal shows some temper carbon, cementite, and ferrite. Etched. Magnification, 100.

Summary

1. Composition of malleable iron is determined by the particular foundry needs, such as design and section size of the castings, and may range from 2.20 per cent C and 1.50 per cent Si, to 2.70 per cent C and 0.80 per cent Si.

2. While chemical composition is important to the final properties of malleable iron, the chemical composition by itself may not give a true picture of the quality of the iron.

3. The melting practice and not the annealing practice will do most to determine the final characteristics of the metal.

Fig. 5—Mottled areas in this annealed iron are due to high silicon content. X100 magnification. Unetched.

4. Overoxidation of the metal during melting should be avoided as it will adversely affect the rate of graphitization.

5. Superheating of the metal at any time during the melting process helps to prevent mottling.

6. Iron should be as close as possible to the final desired analysis at the time the metal is ready for tapping. Large additions to the bath close to tapping time are not as effective as when most of the additions are made with the charge.

7. All annealing cycles fall on the same general shape curve, although some may be shorter than others.

8. Annealing furnace design and method of packing play the most important part in the length of time the cycle will run.

9. Certain gases, such as CO and H_2, will retard the graphitization rate if present in high percentages.

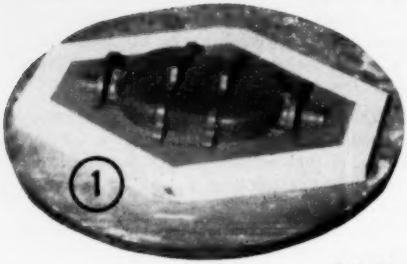
10. Carbide-forming elements will retard or prevent graphitization.

11. Ferrite strengthening elements will promote graphitization and excesses of these elements may produce primary graphitization.

12. Titanium, vanadium and boron act to promote graphitization when used in very small percentages. When an excess of these alloys is present, the tendency is to retard graphitization.

MODERN FOUNDRY METHODS . . .

PLASTIC PATTERNMAKING FOR



E. J. McAfee
Master Patternmaker
Puget Sound Naval Shipyard
Bremerton, Wash.

First introduced to the foundry industry some 10 years ago as a plastic pattern material, phenolic casting resins have proved a definite aid to the production of certain types of quality castings. Best used in matchplate work for machine molding, plastic patterns can be produced economically and are unexcelled for high production work where rough handling does not occur. Non-porous, they do not require the use of parting dopes, or removal from the production line for refinishing.

Plastic patterns or a combination of plastic and wood patterns in many instances will produce better and cleaner molds at less cost where quantity production is required. Small core boxes made of phenolic resin have been used successfully with coreblowing equipment and under test, without wearing sleeves or inserts, they have outlasted aluminum and brass core boxes. It is up to the coremaker to determine at what point it becomes

Fig. 1. Wooden double master pattern with prime coating of enamel undercoat. Prime coat is dried and rubbed with glycerine-dampened cloth, all the parting agent needed before (Fig. 2) spraying pattern with rose metal, a eutectic alloy that melts at 220 F. Gun with metal reservoir mixes hot air blast and melted metal at nozzle. Spray is regulated by nozzle. Fig. 3 shows completion of spraying action. Metal coating averages 1/32 in. thickness, cools instantly in readiness for backing of plaster of paris to insure rigid mold. Frame around master pattern is provided for this purpose. After patterns are cast, metal facing is easily removed and pigged. Fig. 4 shows pouring of casting plaster over metal-sprayed master pattern to give rigidity to mold and to support metal facing. Mold is then dried at temperature below facing melting point.

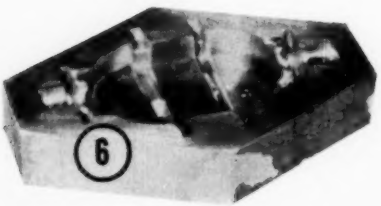


Fig. 5. Removing or drawing master pattern from the mold by use of a bridge and wood screws. This method insures slow, easy draw and protects mold and pattern from damage. Fig. 6 (above) the mold after withdrawal of pattern is a perfect reproduction of pattern.

. . . MODERN FOUNDRY METHODS

THE SMALL PATTERN SHOP

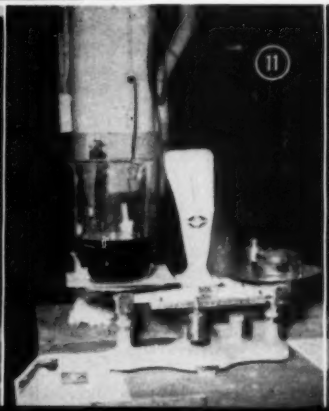
advantageous to use plastic patterns in preference to wood patterns. Factors that must be taken into consideration are (1) quantity of castings desired, (2) relative cost of producing plastic or wood patterns, (3) type of foundry equipment used, (4) upkeep or renewal of worn wood patterns, and (5) relative cost of foundry production with wood or plastic patterns.

Puget Sound Naval Shipyard has developed a method of producing phenolic resin patterns in metal-faced molds. The accompanying illustrations show application of this method to production of a phenolic resin pattern for a small ventilation gate valve bonnet. Metal facing of mold is not required where only one plastic or pattern is needed. Sequence of operations is:

Two patterns are mounted on machine boards, with cope and drag separate. Wooden double master pattern

Fig. 8. As metal facing is a faithful reproduction, flaws of master pattern are removed with fine steel wool. Mold is then polished with a crocus cloth. Fig. 9. Applying plastic paint. After paint is thoroughly dried, either by oven or air drying, coating of beeswax cut with gasoline is brushed lightly over surface and polished. Mold is now ready for use. Fig. 10. Weighing sufficient resin to fill mold to determine amount of accelerator or catalyst to be added. Degree of viscosity increases with time if kept in storage temperatures over 400 F and as viscosity increases due to natural polymerization, phenolic resin becomes more difficult to handle, particularly in removal of air pockets. Fig. 11 shows phenolic resin being weighed to determine correct amount of catalyst required. Fig. 12. Proportions of catalyst to be added vary according to each manufacturer's product and amounts used should correspond with manufacturer's recommendations. Purpose of the catalyst is to accelerate polymerization of the plastic. If phenolic resin is kept in cold storage, it should be restored to temperature of 75 F just before casting.

Fig. 7 (right) shows finished and polished mold ready for application of parting material. Most effective parting agent is plastic paint. One thick or two thin coats should be applied with a fine, soft brush.



MODERN FOUNDRY METHODS . . .

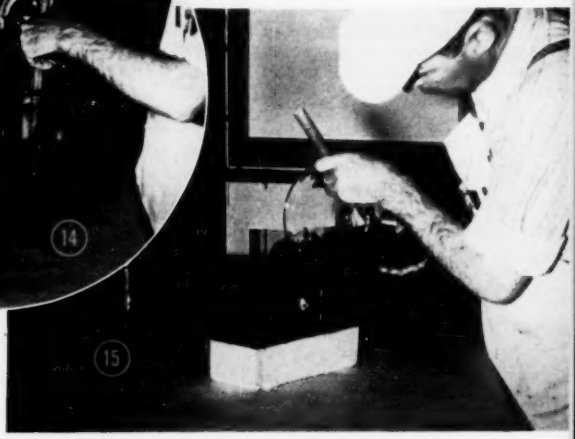


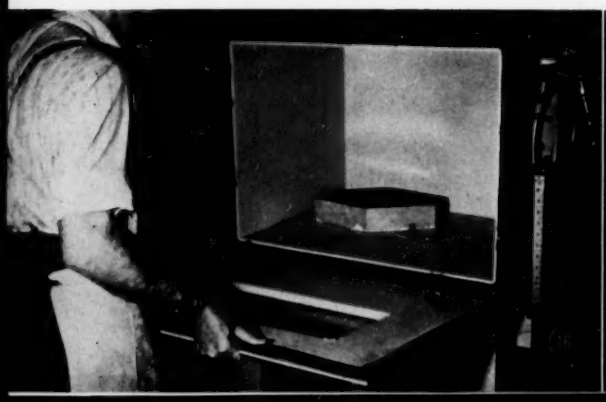
Fig. 13 and 14. Adding catalyst to casting resin. Care must be taken that catalyst is thoroughly mixed with resin or stresses and strains will be present in cured article. Mixing should be done slowly to prevent taking in excessive amount of air, which escapes slowly if not withdrawn by vacuum. If vacuum system is not available, let mixture stand for 15 to 30 minutes before pouring. Fig. 15. Pouring of mold should be done slowly to prevent addition of air to casting. Fig. 16. Placing cast mold in vacuum chamber to draw off trapped air and eliminate bubbles in cured casting. Vacuum treatment may be done either before or after casting or both, but if type of mold permits, removal of air immediately after casting is most effective. Fig. 17. Curing oven is electric, air-ventilated, and has pyrometer controls for maintenance of close-limit temperature range. Thermometer controls vary 20 to 40 degrees F and are unsuitable for good curing. Heat conductivity of mold material influences the curing time.

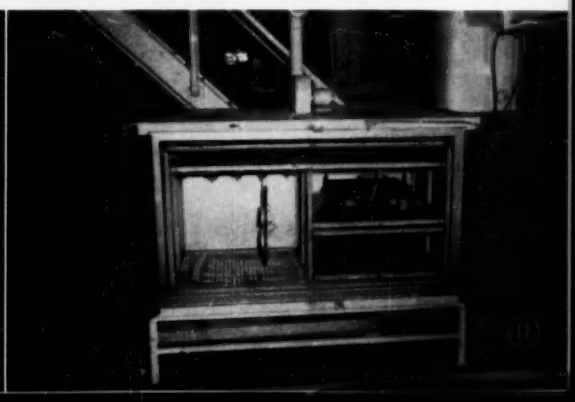
is given prime enamel undercoating and rubbed with glycerine-dampened cloth—all that is necessary as a parting agent. Pattern is then sprayed with approximately 1/32 in. thick coating of rose metal.

Plaster of paris is poured over metal-sprayed master pattern to insure rigid mold. Master pattern is then withdrawn from mold by means of a bridge and wood screws. Imperfections reproduced in mold are removed with fine steel wool and mold is polished with crocus cloth. One or two coats of parting material (plastic paint) are applied with soft brush. After paint is oven or air dried, coating of beeswax cut with gasoline is brushed over surface and polished. Mold is now ready.

Sufficient resin to fill mold is weighed and an acid mixture, or catalyst, is added to resin in proportions recommended by manufacturer. Ratio of resin to catalyst governs length of curing cycle. Catalyst is stirred in slowly and air is withdrawn from mixture by vacuum system or by allowing mixture to stand 15-30 min.

Mold is then poured slowly, to prevent addition of air





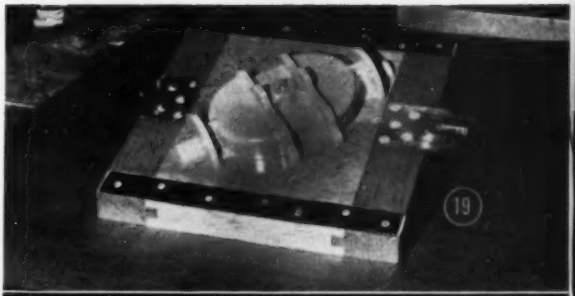
. . . MODERN FOUNDRY METHODS

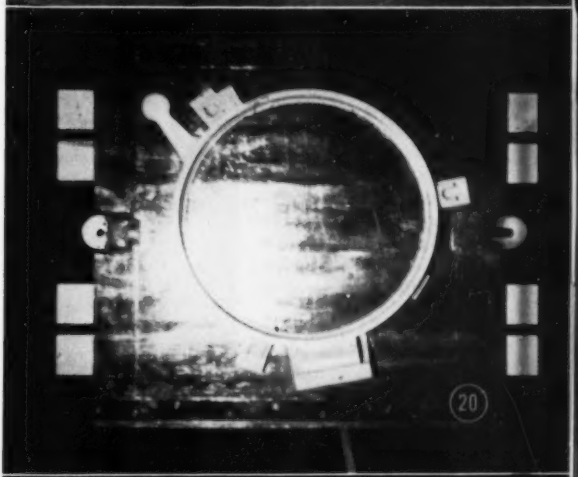
to casting, and placed in vacuum chamber either before or after casting. Mold is next placed in electric air-ventilated curing oven equipped with pyrometer controls. Heat conductivity of mold material influences length of curing time.

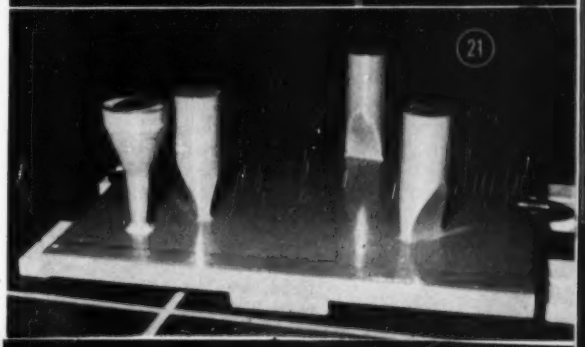
After casting has hardened, usually in from 6 to 8 hours, it is removed from mold. Before removing casting from mold, however, it is desirable to mill or rout casting face until it is level with face of box. Mold is then again brought to curing temperature before removal of casting. Casting is then returned to oven for completion of curing cycle, which lasts from 8 to 40 hours, varying with size of casting. Longer curing improves dimensional stability of casting.

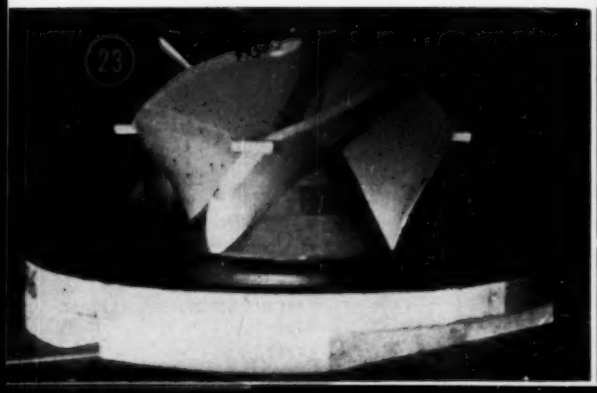
The final step is the removal of the plastic pattern from the mold by means of a bridge and wood screws and mounting it on a wood machine board.

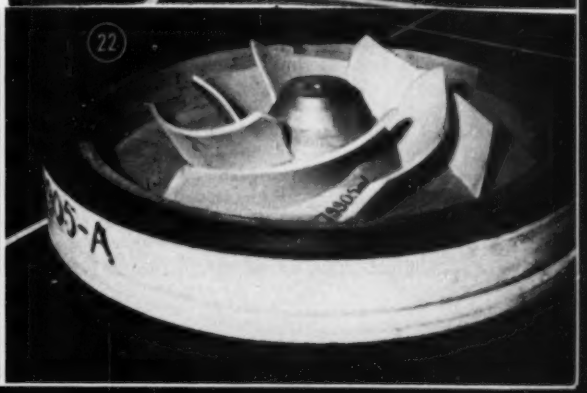
Fig. 18 (above) shows pattern as it looks when it is removed from mold after curing. Pattern is removed by use of bridge and machine screws, as shown in Fig. 5. Pattern has changed from dark molasses color of original resin to opaque cream color. Fig. 19 shows finished plastic pattern mounted on wood machine board with machine screws. This combination will produce several hundred molds without repairs or renovating. In mounting patterns, it must be remembered that phenolic resins expand at excessive heat but revert to original dimensions upon return to normal temperatures. Fig. 20 shows drag board of a 16-in. airport frame for a non-ferrous casting. This is a plastic pattern mounted on a wood board. Fig. 21 shows cope half of same airport ring. Figures 22 and 23 show other combinations of wood and plastic core boxes for a mixed flow or Francis type impeller. Blades are of phenolic cast resin and rest of boxes are of pine or other suitable material. Plastic blades can be made of parallel thicknesses without regard to draft or taper for withdrawing from the green core and can easily be withdrawn without rapping or distortion.











NODULAR IRON SYMPOSIUM SHOWS WE STILL HAVE LONG WAY TO GO

Herbert F. Scobie
Editor
American Foundryman

PRESENT AND FUTURE STATUS of nodular iron, and mechanism of solidification and nodule formation, were examined critically at a symposium attended by nearly 100 metallurgists and foundrymen early in September. Papers presented and discussion from the floor brought out evidence and opinion for the following controversial points:

1. Nodules form spontaneously; they form around small non-metallic inclusions; they precipitate on graphite nuclei.

2. There is a high decree of segregation of graphite nodules; there is no segregation.

3. Mechanical properties are readily reproducible; reproducibility is poor.

4. Nodules contain a nucleus; they do not contain a nucleus.

5. Nodular iron can be produced consistently; nodular iron cannot be obtained consistently from successive ladles taken from the same forehearth.

6. Nodular iron castings have pinholes which can be eliminated by pouring at a higher temperature; nodular iron castings do not have pinholes.

H. F. Taylor

An instructive series of sessions, marked by the high caliber of the papers and the discussions, the symposium was sponsored by Massachusetts Institute of Technology and held at Swampscott, Mass., September 12 and 13. Attending were foundrymen from the South and the Middle West who joined their New England-area colleagues to hear an international roster of speakers. Speakers from outside the United States included these leaders in the field of nodular iron research and development: H. Morrogh, British Cast Iron Research Association, Birmingham, England; Prof. Albert De Sy, University of Ghent, Belgium; and J. E. Rehder, Bureau of Mines, Ottawa, Ont., Canada.

Other speakers were: A. A. Boyles, U. S. Pipe & Foundry Co., Burlington, N. J.; A. P. Gagnebin, International Nickel Co., New York; C. K. Donoho, American Cast Iron Pipe Co., Birmingham, Ala.; John Chipman, head of the metallurgy department, MIT; Warren L. Larson, Dow Chemical Co., Midland, Mich.; B. Floyd Brown, MIT research associate; and Harold N. Bogart, Ford Motor Co., Dearborn, Mich. Opening speaker was John Wulff, head of the metal processing laboratory at MIT. Arrangements for the symposium were under the direction of MIT Professor Howard F. Taylor who presided at several sessions.

Dr. Boyles keynoted the symposium with a discussion entitled *"Our Knowledge of the Mechanism of Formation of Flake Graphite in Cast Iron"* in which he drew heavily on his well-known researches and pointed out that there is still much that is not fully understood. This theme carried over into the talks on nodular iron on which microstructures, properties, and methods of production did not become public in this country until H. Morrogh's classic paper on cerium-treated irons at the 1948 A.F.S. Convention in Philadelphia. New and strange to most foundrymen, nodular iron provides ample opportunity for controversy in metallurgy, metallography, production, and application. This was well brought out as Mr. Morrogh and subsequent speakers offered varying interpretations for phenomena observed in shop and laboratory.

Second speaker of the morning, Morrogh's subject was *"The Mechanism of Formation of Spherulitic Graphite in Cast Iron."* During his comprehensive review of research done under the sponsorship of the British Cast Iron Research Association, he reviewed evidence to indicate that graphite nodules do not form around nuclei. Chairman during the presentation was J. A. Livingston, Cerium Metals Corp., New York.

Presiding over the afternoon session was R. H. Schaefer, American Brake Shoe Co., Mahwah, N. J. In the first talk entitled *"The Status of Ductile Iron in American Industry,"* A. P. Gagnebin said that ductile iron is out of the pilot plant stage and that some 15 or 20 thousand tons of castings would be produced during 1950. He predicted that ductile iron's good castability and mechanical properties would lead to many applications of this family of casting alloys and would eventually make it the third ranking metallic used from a tonnage standpoint with annual production ranging from two to five million tons.

New Iron Has Many Applications

According to Mr. Gagnebin, ductile iron combines the process advantages of gray iron with the product advantages of steel and some of those of gray iron. Illustrations of ductile iron castings shown by the speaker included parts for compressors, a hydraulic press, a turbine casing, pipe, printing press and steel mill rolls, axle housings, a press arm, a 20 ton anvil block, gears including some with flame-hardened teeth, dies for automotive bodies, crankshafts, plow points, and annealing pots.

In introducing the next speaker, C. K. Donoho, Mr. Schaefer commended him and his company for the excellence of their researches and their willingness to report them in detail. Over-all costs of producing nodular iron in a basic-lined cupola are lower than in an acid-lined unit, Mr. Donoho said in his talk, *"Experiences with the Basic lined Cupola for Producing Nod-*

ular Iron." While basic linings and patching are more costly, resistance to burning out is better than in the acid-lined cupola, he stated.

Metal can be de-sulphurized or de-phosphorized (at a sacrifice of most of the silicon), but not in the same heat since sulphur removal requires strong reducing conditions while a high oxidizing condition is required to remove phosphorus. In general, the basic-lined cupola gives a higher silicon loss, lower manganese loss, and higher carbon pickup than the acid-lined cupola, Donoho explained.

Dr. Warren Larson reported data on x-ray diffraction studies of graphite from various ferrous alloys and discussed his work on nodule formation. Nodules appear above and during the eutectic interval which explains the higher shrinkage of nodular iron, he said.

Desulphurization, Theory Discussed

"*Desulphurization*" was the subject of the first day's evening session. Fundamentals of sulphur behavior in liquid metal and transfer of sulphur from metal to slag were covered by Prof. John Chipman. Session chairman was J. T. MacKenzie, American Cast Iron Pipe Co., Birmingham, Ala.

Papers presented the second day included three theoretical discussions and a paper aimed primarily at the production man. Prof. Taylor presided at all these sessions. "*Some Experiments on the Nucleus of Nodular Graphite in Cast Iron*," by J. E. Rehder, evoked considerable discussion with some of the listeners, led by H. Morrogh, denying the existence of a nucleus. Majority, including Speakers Albert De Sy and Harold Bogart, sided with Mr. Rehder.

Rehder showed photomicrographs by ordinary and polarized light which showed nodules with well defined nuclei, and also showed electron micrographs at X15,000 which indicated that the nucleus has a faceted appearance. He described solution of nodular iron over a period of weeks in cold dilute acid to separate nodules, and ashing of the residue at low temperature to removed carbon. Non-metallic inclusions were separated by screening and by heavy liquid. Most startling statement was the speaker's report that nodules are magnetic and that he was conducting a separation from inclusions by magnetic means.

In summarizing his work to date, Rehder said he tentatively concludes:

1. Nodular graphite is the result of growth on specific nuclei.
2. There are radial and non-radial graphite types.
3. A nucleus exists in every nodule.
4. The nucleus is hard, relatively chemically inert.
5. The nucleus is hexagonal in crystal habit.
6. Size and size distribution of nodules is influenced by the nodulizing inoculant used.
7. Nodules contain silicon, iron, and titanium, with the existence of TiO_2 and Fe_2O_3 confirmed by x-ray diffraction.
8. The nucleus may be a carbide or a nitride.

Professor De Sy spoke on "*Current Belgian Research*

Begin Construction of MIT's Sloan Metal Processing Laboratory

Now under construction is the Massachusetts Institute of Technology's $1 million Sloan Metal Processing Laboratory, designed to further education and research in metallurgical science as applied to basic manufacturing processes. Gift of Alfred M. Sloan, Jr., chairman of the Board of General Motors Corp., the laboratory will be four stories high, the first two of which will be devoted to instruction and research in machine tool operations, the third to metalworking and powder metallurgy, and the fourth to a well-equipped foundry and welding laboratory. Recitation and lecture demonstration halls will be located all through the building. The Metal Processing Laboratory, created in 1946 and until now inadequately housed, serves as an interdepartmental laboratory with the objective of applying metallurgy and design to the basic metalworking crafts.

on Spheroidal Graphite Cast Iron" and reported the results of work on carbonized pure iron with silicon added to give essentially a ternary alloy. He also showed electron micrographs which indicated the presence of a nucleus. Inoculants used by the speaker included lithium (with which he had produced nodular iron as early as December 1948), calcium, barium, strontium, sodium, potassium, tellurium, and magnesium.

Lithium does not react as violently as magnesium but the oxide vapor produced is highly caustic, said De Sy. Calcium gives no violent reaction; work included use of 70-30 Cu-Ca, calcium fluoride, calcium chloride, and calcium hydride, the latter reacting violently because of hydrogen generation. Barium and strontium were successful while sodium and potassium produced some nodules, some stubby, round-ended flakes. Tellurium inoculated iron cast in a two-inch bar produced about 30 per cent nodules with the balance flakes.

Graphite nodules are born in supersaturated primary austenite, Prof. De Sy said, basing his conclusions on a study of small quenched specimens of magnesium-treated iron in which nodules appeared in the martensite. Cooling curve studies correlate well with this conclusion, he said. From highly hypereutectic iron, nodules seem to form from the liquid, De Sy stated, as indicated by the location and the grouping of five to 20 nodules in the martensite. Nodules are formed in the fully liquid or fully solid but never at a liquid-solid interface as in flake graphite, he concluded.

A considerable range of hardness and strength above the level of pearlitic nodular irons appears to be obtainable through heat treatment without quench cracking, said Dr. B. Floyd Brown in his talk *"The Heat Treatment of Nodular Cast Iron."* He described an investigation of an iron-carbon-silicon-nickel alloy.

Harold Bogart cited the difficulty of putting nodular iron into automotive production, while agreeing that it is possible to consistently produce nodular iron, at the outset of his talk *"Observations on Nodular Iron."* He outlined investigations at Ford Motor Co. designed to determine properties of nodular iron cast in plates 1, 2, 4, 6, and 8 in. thick with physical properties determined as cast and after annealing.

Curves for tensile strength, yield point, elongation, and impact showed a section-size effect with lower properties in the heavier sections. This influence was particularly pronounced in the impact values for the high strength nodular iron. The high ductility iron, as cast, was more influenced by the percentage of residual magnesium with the properties reaching a maximum at 0.025-0.045 per cent. Best properties are obtained, said Mr. Bogart, at the lowest magnesium residual which produces a fully nodular structure. Objective at Ford, he explained, is to operate with residual magnesium around 0.035 per cent with additions gaged to allow for interval between inoculation and pouring.

Areas needing further investigation to make nodular iron a widely accepted article of commerce, enumerated by Bogart, are: control of spout temperature, alloy additions, chemistry of base iron, melting practice, etc.

Chapter Honors Foundry Student

Walter Dziwulski (left), adjudged the outstanding foundry student for 1949-50 at Buffalo State Technical Institute, University of the State of New York, is shown receiving an award of merit from the A.F.S. Western New York Chapter at a ceremony held August 8. Making the presentation is Alfred A. Diebold of the Atlas Steel Casting Co., chapter chairman.

Investigate Practicability Of Casting One-Piece Magnesium Plane Wings

POSSIBILITY of casting entire airplane wings from magnesium is currently being investigated by scientists of Northrop Aircraft, Inc., Hawthorne, Calif., at the request of the United States Air Force.

It is believed that this method of wing manufacture would have great advantages in the event of a national emergency. The supply of magnesium, extracted from sea water, is almost limitless, and foundry facilities and personnel can be expanded much more rapidly than facilities for producing aluminum extrusions and forgings. A large saving in time and equipment would be effected by casting the wings, as compared to that required for the conventional fabrication of riveted airplane structures, it is claimed.

Working in conjunction with foundries specializing in the light metals field, Northrop hopes to obtain a structure free of porosity and adhering to extremely close tolerances.

Graphite Classification Chart Ready

REVISED AND REPRINTED, copies of the A.F.S. Graphite Classification chart, supplanting a similar chart produced by the American Society for Testing Materials and now out of print, are now available from A.F.S. headquarters. Suitable for framing and measuring 25 x 38 in., copies are available at $1.75 each to non-members or $1.25 each to A.F.S. members, with a substantial discount for quantities of 25 or more, from American Foundrymen's Society, 616 S. Michigan Ave., Chicago, 5, Ill.

INDIA'S IRON PILLAR OF QUTAB MYSTERY CASTING OR WELDMENT?

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INDIA's centuries-old metallurgical puzzle—the famous LOH Stamph (Iron Pillar) of Qutab, near Delhi—has for many years been a center of conflicting opinions as to its origin and as to whether it is cast or is a series of forged plates welded together to form a column. Generally believed to have been erected about 400 A.D. by India's King Chandra as a votive offering to the Hindu god Vishnu, the soft iron pillar today is marred by hundreds of signatures scratched into its surface by tourists' penknives and still bears the scar of a cannon shot fired by the soldiers of one of India's invaders in 1738. This conquering prince, Nadir Shah, resented any monument to a ruler other than himself and ordered the pillar uprooted, but it was too firmly imbedded. As a last resort, he ordered a cannon fired at it but the ball succeeded only in denting the iron of the pillar.

In company with a responsible officer of India's Archeological Department, the author made a detailed examination of the pillar. Our findings definitely confirm that it is a one-piece casting. Imbedded three feet in the ground, where it is firmly held in place by eight iron bars attached to stone blocks, the pillar rises to a height of 20 feet, 7 inches above the ground, making its total height 23 feet, 7 inches.

An elaborate bell-shaped molded capital 3 feet, 7 inches long surmounts the shaft proper, which tapers from a 59-inch base circumference to a 38-inch circumference at a point just below the capital. This tapering alone eliminates the possibility that the pillar is made up of round iron plates welded together. Upon close examination, the lower portion of the pillar is so shaped that it could only be a casting.

Eminent British and Indian archeological and historical authorities differ widely as to the proper name and the origin of the pillar. Most of these theories result from the ambiguous and vaguely-worded Sanskrit inscription on the pillar, which is roughly translated:

"He, on whose fame was inscribed by the several, when in battle in the Vanga Countries, he kneaded and turned back with his breast the enemies who uniting together came against him—he, by whom having crossed in warfare the seven mouths of the river Indus Sindhu, the Vahlika were conquered he, by the breezes of whose prowess the Southern Ocean is even still perfumed. He the remnant of the great glowing heat of the burned-out fire in a great forest even now leaves not the earth, though he, the King as if wearied has quitted this earth and has gone to the other world, moving in bodily to the land of paradise won by his actions, but remaining on this earth by the memory of his fame. By whom the King, who attained sole supreme sovereignty in the world, acquired by his own arm and enjoyed for a long time, and who having the name of Chandra carried a beauty of countenance like the beauty of the full moon, having faith fixed his mind upon the god Vishnu. Lofty standard of the Divine Vishnu was set upon the hill called 'Vishnuped'."

Small wonder that the Sanskrit experts' interpretations of this inscription are not in agreement! One expert says the pillar was constructed by the Raja Madhva in 895 B. C.; another that it was constructed by the Raja Dhava in the third or fourth century A.D.; while the majority of experts subscribe to the theory that Maharaja Chandra built it in the fifth century in honor of Vishnu.

However much these experts may argue over the origin of the pillar, and as to whether it is a casting or a weldment, they are all in accord as to its being one of the metallurgical wonders of the ancient world.

Early in the 1920's Sir Robert Hadfield made a chemical analysis of the pillar: carbon, 0.080; silicon, 0.046; sulphur, nil; phosphorous, 0.114; manganese, nil; total impurities, 0.246; and specific gravity, 7.81.

That the ancient Hindus were no mean metallurgists is brought out by this tribute from a British archeologist, H. A. Newell, who wrote:

"It almost savors of magic to discover that although the column has been exposed to the storms of 1700 years, not a particle of dust corrodes its smooth surface and the inscription is as sharply defined and as legible as the day it was first cut.

"It is a forged bar of pure, unrusting iron nearly 24 feet high and said to weigh six tons, gracefully molded at the top and so strong that a cannon fired at it did little injury."

Whether a casting or a weldment, the Iron Pillar of Qutab plays an important role in the history and folk lore of India. There is in fact a legend to the effect that a Rajput prince moved the pillar from the ancient capital of Hindustan to its present location sometime during the 11th century and, so says the legend, as the foundations of the piliar were loosened so were the foundations of the Prince's reign loosened and his empire tottered and fell shortly afterward.

gray iron WELDING JOINING CUTTING

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This is the first section of the material on elevated temperature methods of welding, joining, and cutting gray iron, which will constitute Chapter VII of the *Gray Iron Handbook*, to be issued by the Gray Iron Founders' Society, Inc. The remainder of the article will appear in future issues of AMERICAN FOUNDRYMAN.

GRAY IRON AND GRAY IRON CASTINGS can be successfully welded if certain simple but essential practices are employed. Such a statement would appear obvious if for many years it had not been believed that there were no suitable methods of joining gray iron castings, and broken castings were frequently discarded without any attempt at salvage. The use of assemblies fabricated from castings was not even considered. As a result of this belief gray iron was replaced in certain types of construction by other materials which, although less suited to the application from other points of view, could be easily welded by known processes.

Delay in developing welding techniques peculiarly suited to gray iron was partly due to the fact that in a large number of applications the use of gray iron eliminates all need for weldments. The flexibility inherent in the casting process, particularly when this is combined with the ready castability and ultimate economy peculiar to gray iron, very often renders a single integral gray iron casting preferable to a weldment. Welding was thus largely confined to a repair or maintenance operation, and a large proportion of gray iron welding is still done in this field.

Outside of such operations there are, however, two main cases in which joining of castings by welding may be desirable: (1) if the requirements of the part necessitate the use of another metal in integral combination with gray iron; and (2) if the design of the structure is extremely intricate, so that casting in one piece presents problems to the foundryman which cannot be solved economically even by the use of good foundry practice.

Weld Gray Iron in Fabricated Assemblies

It should be emphasized that such cases as the latter are not common but do exist. There is no question but that castings of extreme intricacy can be produced by the foundry with consistency by the use of proper gating, coring and risering. However, cost of cleaning out inaccessible cored cavities, etc., occasionally overbalances the advantages of integral cast construction.

As mentioned previously, until recent times it has been the custom of designers, whenever either of these difficulties has been encountered, to abandon gray iron and substitute another material considered as more weldable. This prejudice against the use of gray iron in fabricated assemblies is no longer justified. Recent progress in joining technique has demonstrated that, with proper precautions, gray iron castings can be satisfactorily welded or joined to other metals.

It is true that these approved welding procedures generally require skill, special rods or preheating, and to that degree may be more expensive to apply in the case of gray iron than in the case of mild steel; nevertheless, ultimate economy frequently results from the use of an inexpensive base material, and more important, from the improvement of the final product resulting from the ability of the designer to freely employ the valuable qualities of gray iron wherever they are needed.

As already noted, interest in welding gray iron arose originally from the desire to repair castings which failed in service, or to correct imperfections in new castings produced in the foundry. This is still largely the case, and most of the available information herein contained is based on repair welding.

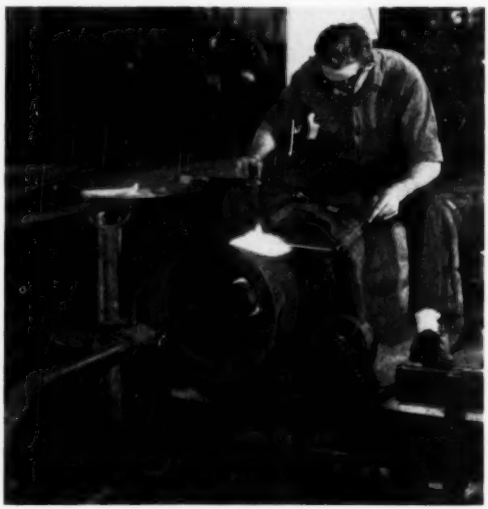


Fig. 1.—The circumferential method of production welding is used to weld centrifugally cast gray iron pipe to gray iron casting, using gray iron filler rod. Torch inserted in open end of pipe preheats welding area.

However, some improved, older processes, as well as newer procedures, notably braze welding with bronze and nickel filler metal and brazing with silver alloys, have been recently used in fabrication. As a result of the present development of new processes and the increased understanding of processes already in use, employment of gray iron in welded assemblies will undoubtedly expand.

The lack of success encountered by many operators in their attempts to weld gray iron has, in general, resulted from their efforts to apply to that material the methods developed for the welding of mild steel. Because of insufficient appreciation of the differences in structure and properties between these two materials, these attempts have on occasion resulted in poor welds, and in some cases cracking or fracturing of castings.

Two of the distinguishing characteristics of gray iron are its rigidity and high carbon content, and it is precisely these characteristics which need to be considered in the welding of gray iron. For example, if one section of a casting is heated to the welding temperature, in common with all ferrous materials it will expand beyond its normal length. This causes no trouble if the design will permit free expansion.

However, if a closed or rigid construction exists, considerable stress will develop in other cooler sections of the casting. Thus, if a casting or any metal part shaped like the letter "A" is heated at the crossbar, this section of the casting will expand, putting considerable stress on the apex of the A. If this induced strain is greater than the tensile strength of the metal, a fracture will occur at the apex (or more probably, since the apex would be reinforced, at a point on one of the legs just below the apex).

Once this danger of breaking is understood, suitable steps can be taken to prevent it. For example, preheating either the entire casting to a moderate temperature, or those sections which will be subject to stress, will both insure uniform expansion of the casting, so that the expansion of the welded part will be largely compensated for by the expansion of the parts which might be under stress, and permit some movement of such stressed sections.

The high carbon content of gray iron, and the fact that the greater portion of the total carbon should be present as graphite flakes in the finished weld, also influence welding operations. Graphite flakes give gray iron some of its most valuable properties, such as wear resistance, damping capacity, high compressive strength, resistance to notch sensitivity or warpage and, in particular, excellent machinability. To retain these valuable properties the use of preheating in arc welding or other fusion methods where cooling rate of the weld cannot be as readily controlled as in gas welding is advisable.

If an iron of high carbon content is very rapidly cooled from the molten state, such as may occur in arc welding, the carbon does not have time to separate out in the form of graphite flakes, but is largely or entirely retained as cementite, a compound of iron and carbon. An iron containing a relatively large percentage of cementite has either a mottled or white fracture, and is, therefore, called mottled or white iron. White iron, although very hard and sometimes deliberately produced by chilling a gray iron casting for wear-resistant purposes, is comparatively brittle and practically unmachinable.

For this reason, if the molten weld metal or metal adjacent to the weld is allowed to cool too quickly, the resultant weld will have a brittle structure (the cooling stresses may even be sufficient to cause fracture), and it will be very difficult to machine. If steel welding rods are employed, this condition may be aggravated by dilution of the base gray iron. In addition, under certain arc-welding conditions where very rapid heat extraction takes place, a narrow, hard, martensitic zone may exist in the weld or adjacent area (heat affected zone) such as may be encountered under similar welding conditions with a medium or high carbon steel.

There are, in this regard, two general solutions for these problems: (1) preheat and/or postheat may be employed. In the preheating, the entire casting

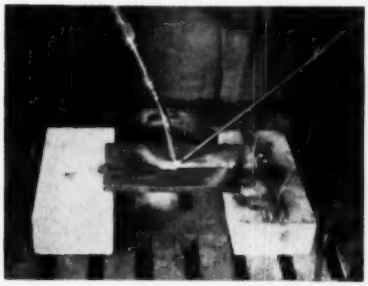


Fig. 2 (above)—Proper use of the forehand welding technique is demonstrated in the welding of gray iron test coupons. Fig. 3 (right)—Several welders work together at oxy-acetylene welding of a gray iron gear, using gray iron welding rods.

or a localized zone adjacent to the weld are brought to a high temperature, so that the mass of cold metal behind the weld will not rapidly abstract heat and have the above indicated chilling effect.

A postheat, always followed by slow cooling, may be employed to relieve any residual stresses left from the welding operation. After welding it is desirable to cover the casting with asbestos paper, bury it in sand, cool in a furnace, or in some other way insure that it is kept from drafts and allowed to cool slowly. Very often under such circumstances sufficient residual heat will be left to eliminate the necessity of postheat, but in some cases where very accurate dimensions must be maintained, postheat is still advised.

(2) The other method of avoiding the formation of white iron or martensite is to keep the weld and adjacent metal as cool as possible during fusion, usually by the use of non-ferrous electrodes of lower melting point than gray iron and/or by welding slowly, allowing each deposit to cool before depositing any more metal. If possible, these devices should be combined.

If the welds are to be gray in structure, it should be recalled that the formation of graphite flakes depends to a large extent on the presence of adequate silicon in gray iron, as well as the above delayed cooling. Some silicon is burned out of the iron at the high temperatures of fusion welding. In order to maintain a sufficient quantity of silicon to insure the formation of gray iron, electrodes or welding rods of gray iron containing enough silicon to replace that oxidized during the welding process are normally selected.

Gas Welding: In gas welding the heat necessary to complete the welding process is supplied by the combustion of fuel gas with oxygen. In almost every case the gas used is a mixture of oxygen and acetylene, and the process is called oxy-acetylene welding.

There are certain advantages of the oxy-acetylene process which render it particularly valuable for the welding of gray iron. The most important of these advantages is the ability to control the heat input. By careful manipulation of the torch, the metal can be kept within a fairly narrow temperature range, thus minimizing the danger of superheating and consequent run-off of metal during welding operations.

Furthermore, in many cases, the torch may be used to preheat and postheat the weld, so that a minimum of auxiliary equipment is necessary. If the process is one such as braze welding, in which the base metal should not be melted to any appreciable degree, oxy-acetylene welding can insure a low enough temperature to prevent base metal fusion.

On the other hand, it should be noted that the process is somewhat slower than arc welding and consequently may involve an increased labor cost. Furthermore, although the temperature can be more carefully controlled, and local preheating is possible in gas welding, the heat is less concentrated and more heating and overall expansion of the surrounding area may take place, so that preheating of large casting sections may often be necessary to minimize the danger of cracking from stresses induced by thermal expansion in the weld area.

Any disadvantages of oxy-acetylene welding, however, are more than offset by its advantages to the extent that, despite the recent development of nickel and nickel-base electrodes for arc welding, gas welding is generally considered the most foolproof method of joining gray iron from the standpoint of strength, machinability and uniformity of results.

Fig. 4 (left)—A gray iron wheel was repaired by oxy-acetylene welding with a gray iron rod (Fig. 5 right).

1. Oxy-acetylene Welding With a Gray Iron Welding Rod: The use of a gray iron welding rod in oxy-acetylene welding insures a deposit of the same color, composition and structure as the base metal. The bond, if the weld is properly made, will be as strong as the original casting. The process is less expensive than braze welding and, unlike braze welding, can be applied to castings which are to be enamelled. If special precautions are taken, it can also be applied in some cases to castings which have been oil-soaked or exposed to heat. It is the process which insures the greatest success in the welding of gray iron.

Castings to be welded must first be "veed" to an angle of 60°-90°. The vee should not extend completely through the casting or sections to be assembled because such a vee would make the pieces difficult to align and would possibly result in melting through the entire section.[1] If this precaution is not taken, a graphite backing plate may be found desirable.

On small castings the vee should be made with a

grinding wheel. If the section is greater than one inch in thickness a cutting torch may be used. For repair welding a pneumatic chipping hammer may be employed. In such cases only rough chipping should be done and the vee finished by grinding, since chipping tends to partially cover up defects.[2] If a crack is already present in a casting, it is common to prevent its propagation by drilling a hole at each end of the crack and locally preheating.

Next the casting must be preheated as a whole or locally in critical sections if a closed or rigid construction is involved. In the majority of cases this involves preheating the entire casting to 800-1050 F, or as high as 1250 F in the case of alloy castings. The usual preheat should not exceed a temperature of 50 F below the critical point.[2] However, in certain special instances, such as in the case of diesel cylinder heads, a preheat of 1400 F has been recommended.[24]

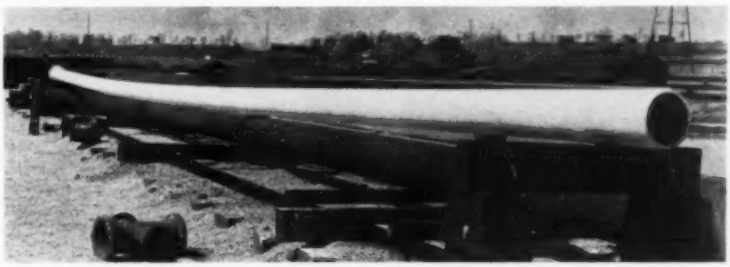


Fig. 6—Three 16-ft lengths of 6-in. gray iron pipe were oxy-acetylene welded, using a gray iron filler rod of approximately the same composition as the material being welded.

The preheat not only equalizes expansion and contraction stresses and, as previously described, insures the machinability of the final weld, but it also enables the weld to be made much more rapidly, with substantial savings of labor and gas.[1] If the casting does not exceed about 25 lb in weight, preheating is generally done with the torch. Otherwise, it is more economical to employ a charcoal fire or a furnace. Induction heating has also been used.[19]

As indicated above, simply a local preheat, with the torch, of the vee and the surrounding metal may be used on welding small castings, or on non-critical parts, corners, curved sections, etc., of large castings.[3] In this latter case, however, it is still advisable to preheat the entire casting to approximately 500-600 F.[4]

The rod used in welding gray iron should have a composition high in carbon and silicon, since the heat of the torch will burn out a portion of these two elements in the final weld. Two recommended rod compositions are as follows. No. 1 is designed for positions where a more fluid metal is desired; No. 2 is suitable for build-ups.[15]

No. 1, Composition, %		No. 2, Composition, %	
C	3.20-3.70	C	3.20-3.70
Si	2.70-3.50	Si	2.75-3.50
P	0.50-0.75	P	0.55 max.
Mn	0.50-0.75	Mn	0.50-0.75
S	0.12 max.	S	0.12 max.

If an alloy gray iron is being welded, or if a very strong, dense weld is desired, an alloy rod may be used. Many rod compositions have been suggested containing chromium, nickel, molybdenum, copper or vanadium either singly or in combination. The final selection usually depends, in addition to strength, on welding characteristics, resistance to excessive hardening, and, of course, cost considerations. Typical compositions [5,53] of high strength alloys rods are:

Composition, %		Composition, %	
C	3.30 max.	C	2.90-3.20
Si	1.75 max.	Si	2.75-3.25
Mn	0.50-0.75	Mn	0.70-0.90
S	0.10 max.	S	0.10 max.
P	0.25 max.	P	0.30 max.
Cr	0.25-0.60	V	0.15-0.25
Ni	1.50 min.		
Mo	0.25-0.60		

The oxy-acetylene flame used for the fusion welding of gray iron should be neutral,[1] although some authorities recommend occasional use of a slight excess of acetylene where carbon burn-out in the welding operation is a factor.[4] The welding tip should be of the high velocity type with a concentrated flame pattern.[55]

A flux is always required for gray iron welding. The purpose of the flux is to increase the fluidity of the otherwise hardly fusible iron silicate slag that forms on the molten puddle. These fluxes usually consist mainly of borates or boric acid and soda ash with small amounts of sodium chloride, ammonium sulphate, iron oxide, etc. One flux that has been used successfully in a large automotive foundry consists of 41½ per cent boric acid, 41½ per cent soda ash, 2 per cent ammonium sulphate, and 15 per cent powdered iron.[3] The greater percentage of the fluxes used for gray iron welding, however, are proprietary.

Some idea of typical filler rod diameters and welding tip orifice sizes can be gained from the following table representing the standard practice at one captive foundry:

Material Thickness, in.	Orifice Size, in.	Filler Rod, in.
¼-⅜	0.070 max.	¼ dia. max.
½-¾	0.098 max.	5/16 dia. max.
Over ¾	0.150 max.	⅜ dia. max.[4]

After the vee has been prepared and the casting preheated, the torch is run over the weld and an area one inch around the weld until the entire area is a dull red. Then the flame is directed at the bottom of the vee, keeping the tip of the cone ⅛ to ¼ in. from

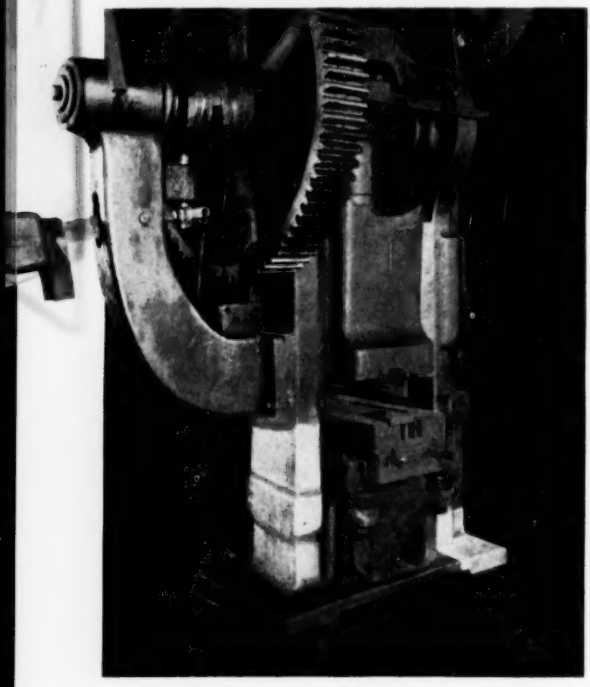
the metal, until a molten puddle approximately one inch long has been formed. Then the flame is gradually moved from side to side until the edges of the vee begin to melt down into the puddle.[1]

The tip of the rod is next heated in the flame and dipped in flux. The rod is introduced into the puddle and the flame directed on the rod. If the flame is directed on the molten puddle, porosity will usually result. The welder should also avoid holding the rod above the puddle and allowing drops of molten metal to fall into the puddle.[1]

Both the backhand and the forehand technique have been recommended for welding gray iron. The backhand technique, in which the torch, directed back toward the welding rod, leads the progression of the weld, is said to insure penetration and, since the operator keeps the flame directed back on the weld metal and rod, to enable more careful temperature control.[1,55] On the other hand, many experienced welders prefer the forehand technique, in which the rod is pointed back toward the torch and leads the progression of the weld. This is said by its proponents to be a more rapid method and to enable more successful working out of oxide and slag inclusions.[24,55]

In both methods the sides of the vee are melted ahead of the advancing puddle, the final choice of method evidently depending on the technique with which a particular welder is most familiar. No layer should be greater than ⅜ in. thick. This requirement is usually accomplished by step or increment welding, in which advancing layers of weld metal are deposited in a progressive series of 1-in. long steps. Enough reinforcement is employed on the final weld to allow for surface finishing.

Fig. 7—The oxy-acetylene braze welding method was employed in repairing a 5500-lb gray iron press frame.



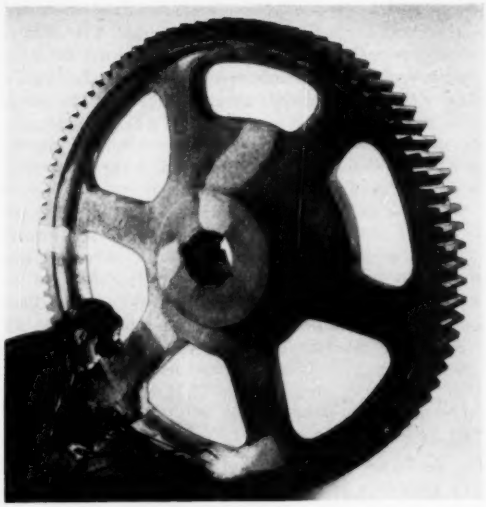


Fig. 8—A 2½-ton gray iron gear was repaired by oxy-acetylene braze welding. Weld metal tensile strength around 45,000 psi is not uncommon in braze welding.

While making the weld, and after the weld is completed, it is advisable to run the flame back over the previously deposited metal.[7] This is normally sufficient to relieve residual stresses, although in the case of rigid structures requiring extensive machining operations stress relieving at the preheat temperature is advisable as a safety precaution.[5,8,24] In any case, it is recommended that the casting be allowed to cool slowly, by covering with asbestos, burying in sand, or in a furnace to a temperature around 550 F or below if possible.[3]

If the above procedure is followed, a strong, homogeneous, machinable weld is formed that will be similar in properties to the parent metal.

2. Oxy-acetylene Braze Welding: The use of a bronze or more accurately a copper-zinc filler rod with the oxy-acetylene torch for the welding of gray iron presents certain advantages which make it definitely a competitive process to welding with a gray iron welding rod for weldments not subject to electrolytic corrosion or high temperature service. These advantages are largely in the direction of simplification.

For example, if preheating is employed at all in braze welding, it can be done at substantially lower temperatures, and the welding process itself is conducted more rapidly, resulting in savings in gas and labor which balance to some extent the higher cost of the bronze rods. The base metal is not appreciably melted in braze welding, with consequent reduced danger of warpage. Because of the lower melting temperatures of the non-ferrous welding rods used, heat-

treated parts, except at the immediate weld area, are often unaffected by braze welding.

Large castings can frequently be welded in position by this process because of the elimination of a preheat. A careful welder can take advantage of the low elastic modulus of bronze at high temperatures to minimize residual stress and warpage. If chilled or mottled iron areas are already present in a casting, it should also be mentioned that braze welding presents the most successful method to date of joining white iron.

There are, of course, limitations to the process. Badly oil soaked or oxidized castings are often impossible to braze weld and, in general, cleaning must be more thorough than for other welding methods. However, a considerable amount of oil can be removed in normal welding or brazing. If a color match is desirable, braze welding normally can not be used, although a nickel-brass rod with a color closely approximating that of ferrous metals has recently been developed.

The tensile strength of the weld decreases at temperatures above 500 F, and it is impossible to enamel welds made by braze welding. Bronze shrinks to a greater degree than iron, and designs should be watched to be sure excessive stresses are not imposed, particularly if one of the lower strength gray irons is employed. The bronze weld metal will react with certain chemicals, such as ammonia, and should not be used in places where it will come in contact with such materials.

Despite such limitations in cases where a strong, dependable weld is desired, where time is of importance, or where a large casting which cannot be successfully preheated to a high temperature is to be welded, braze welding is the most satisfactory joining process. Tensile strengths as high as 55,000–70,000 psi can be developed in the weld metal.

In the braze welding of gray iron most of the difficulties arise from the presence of graphite on the surface of the casting. The bronze bonds with the iron by a tinning action, i. e., by a slight interfacial alloying action and by some penetration between grain boundries. Graphite acts to prevent the bronze weld metal from coming into intimate contact with the iron, and obviously the larger the percentage of graphite on the surface, the more difficult is the joining process. Although a "tinning" flux is used, the mose effective method of degraphitizing is by "searing" the surfaces to be welded at 1600 F with a flame made slightly oxidizing.

To facilitate the vital "tinning" operation—that is, the alloying and penetration which bonds the weld metal to the gray iron—it is always advisable to avoid initially smearing the graphite on the surface during the cleaning and machining operations preparatory to welding. If possible, metal should be removed by chipping, for some machining and grinding operations may spread the graphite over the face of the casting;[8] if possible the vee should be sandblasted.[9] If sandblasting fails to clean the surface and any great trouble is encountered, the use of an oxidizing agent, e. g., potassium chlorate, is recommended.[10] The vee should be of approximately the same shape as that used for welding with a cast iron rod, although both the collar type and the shear vee type weld have been used for bronze welding gray iron pipe.[26]

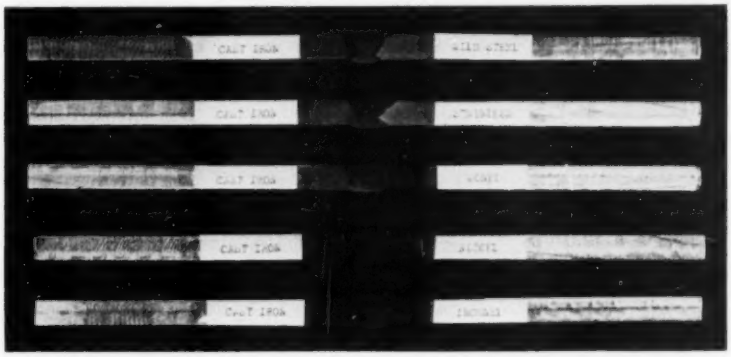


Fig. 9—Arc welding with nickel-base electrodes permits the welding of gray iron to dissimilar metals. Welding may be accomplished in all positions due to rapid solidification of the weld metal.

A wide variety of rods are employed for bronze welding. Basically the material used is 60 per cent copper, 40 per cent zinc,[8] but 0.50-0.70 per cent tin is almost always added.[10] A small quantity of silicon of the order of 0.10 per cent is introduced to cut down fuming and produce the so-called "non-fuming" bronze rods. A small amount of manganese will facilitate tinning and raise the tensile strength of the deposit. The addition of nickel is also occasionally used to increase strength.[9] As previously noted, weld metal strengths of 45,000 psi are not uncommon. Most common bronze welding fluxes are satisfactory.[54]

Although in the majority of cases the vee alone is preheated, a strong opinion exists that the casting should preferably, but not necessarily, be preheated to 600-750 F or higher. This reduces the danger of accidental cracking and enables the weld to be made quickly. Castings of very unequal section thickness should always be preheated.[9]

In the actual welding operation, the base material is placed in a flat position or in such position that it can be welded uphill.[9,10] The vee and the area immediately surrounding it are warmed by the torch, and an area about 3 in. long at the beginning of the weld is heated until it begins to show a red color.

The welding rod is warmed in the flame, and dipped in flux.

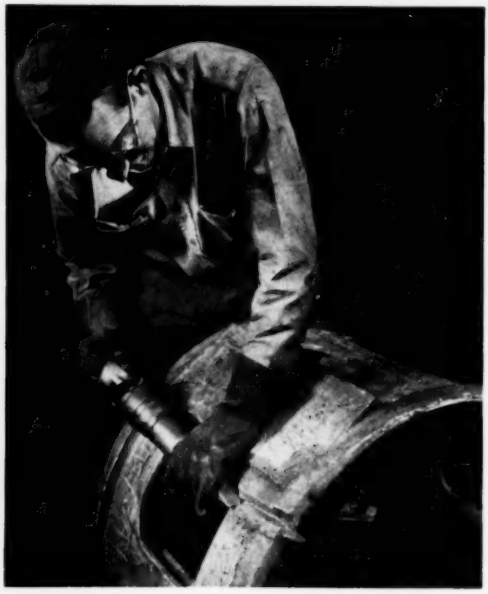
A small amount of the rod is melted onto the surface of the vee. If it forms drops and tends to roll off, the metal is not yet hot enough and tinning is not taking place.[1] If the deposited metal boils and forms into little balls, the metal is too hot.[11] The metal is then brought to the proper temperature and the vee is "tinned" to a length of about 3 in. The welding tip should be of the type which produces a bulbous flame.

The welding may now proceed rapidly using the forehand technique with care to observe that the bronze at all times "tins" ahead of the weld. This is indicated by a concave appearance of the deposited bronze. Although this action is practically automatic with a well prepared vee, the first pass in particular should have a concave face, as should all succeeding passes except the final build-up. After welding, the casting is allowed to cool slowly.[1]

Arc Welding: In arc welding the heat of welding is supplied by an electric arc struck between the casting to be welded and an electrode. In the methods most commonly used with gray iron, this electrode is also the metal to be deposited. The heat of the arc melts the electrode and, since it yields a very concentrated heat, a small area of the base metal under the arc is also melted.

Since with this method of welding only a very limited area of the casting is raised to a high temperature, it is sometimes unnecessary when non-ferrous or steel electrodes are employed to preheat the entire casting to eliminate expansion and contraction stresses. This avoidance of the preheating step, coupled with the fact that metal can be rapidly deposited by the arc method, means that arc welds in large castings can be completed in a comparatively short time.

Fig. 10—Chipping hammer is used to prepare gray iron motor frame for arc welding with nickel electrode.



Because the weld does not remain fluid for any appreciable length of time, arc welding generally can be accomplished in any position, whereas in the case of gas welding, the work cannot be welded overhead and only with difficulty at steep angles.

These general advantages have led to the use of arc welding for the joining of cast iron in a large number of applications. The limitations, arising mainly from the difficulties of temperature control, which in turn may result in hard zones, render it a process supplementary to gas welding but not a replacement of it.

1. Arc Welding With Nickel-Base Electrodes: One of the most widely used and generally successful of the arc welding processes for gray iron is arc welding done with nickel-base electrodes. In this process the electrode is composed of pure nickel or some alloy or combination of nickel and other metals, usually copper. Although it has still not been finally determined, the most successful electrode seems to be one composed of a flux-coated, commercially pure (99 per cent) nickel. Monel metal (70 per cent Ni, 30 per cent Cu) and copper-sheathed nickel are also used as electrode materials.

Fig. 11—Peening marks are shown on the completed repair weld of the gray iron motor frame shown in Fig. 10.

Special nickel electrodes for nickel austenitic cast irons and for high phosphorus irons have also been developed. If machinability is not desired, an electrode consisting of a nickel core, wrapped in a copper sheath, the whole wrapped in a mild steel sheath and heavily flux-coated, has been used with success for build-up purposes.

With the exception of the last mentioned electrode, all the above materials are used when a machinable

weld is desired. Machinability is generally obtained even in the absence of preheating. Their use constitutes an effective method both of producing a weld in a defective or mismachined casting and, in some cases, of fabricating new parts for assemblies which are to be machined. The process is rapid and the electrode is easy to handle and, unlike the bronze electrodes, can be operated in all positions. These advantages have resulted in the use of nickel-arc welding for a large precentage of general gray iron welding jobs.

However, limitations do exist in the use of nickel electrodes. Graphite is used in some flux coatings to facilitate welding, and this graphite in heavy welded sections may dissolve in the nickel and precipitate on cooling in an intergranular and interdendritic form which materially weakens the weld. The weld metal is also susceptible to cracking in thick sections. As a consequence, some operators [35]

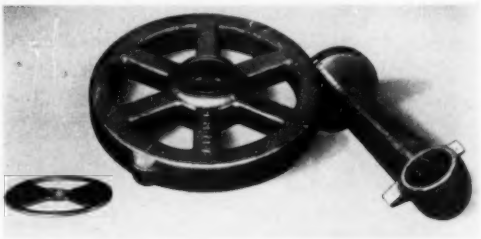


Fig. 12—Gray iron burner for gas home-heating unit is ready for assembly. The slotted disc is made of steel.

state nickel welding should not be used in critical locations. It may safely be said, however, that for repair of surface defects or joining only moderately thick sections nickel-arc welding provides a satisfactory and simple process for welding gray iron.

Veeing is carried out in the same way as for other types of welding. A preheat is generally not necessary, as temperatures over 300 F may result in overheating of the base metal at the line of fusion and consequent formation of an unmachinable white iron layer or a martensitic zone. However, if the casting is below normal room temperature, a moderate preheat of 150-250 F would be applied at the welding area or, if possible, to the entire casting. If the casting is oil impregnated, it is recommended that the area of the weld be heated to 700-1000 F for 15-30 min with a torch and then allowed to cool to room temperature [12] before welding is started.

When nickel welding gray iron it is important to remember: (1) to keep the weld as cool as possible; and (2) to avoid alloying of the nickel with base metal. The smallest possible electrode should be used, and an arc length of approximately 1/16 in. should be maintained.[13] Low amperage alternating current is reportedly preferred because it reduces "arc blow" and generally improves arc control.[3] Reversed polarity direct current is also used.

In general, it is advisable to deposit short, straight beads 1 to 2 in. long. Each bead should then be lightly peened [8] with ball-point tools and allowed to cool to a temperature such that it can be touched with the finger.[15] It is advisable to remove the flux from each pass before starting a subsequent pass by scratching with the corner of a cold chisel and brushing with a wire brush.[25] If parallel beads are being deposited, the arc should be directed at a previously deposited bead. As a typical example, the arc should never be directed at a corner or edge but always at the nearest bead.[14]

Small surface imperfections have been successfully filled by the use of the "dot-welding" technique, in

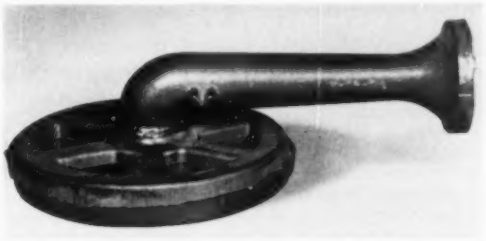


Fig. 13—Gray iron gas burner (Fig. 12) is shown after production assembly by arc welding with nickel electrode.

which a high amperage, low voltage, alternating current, interrupted arc is employed to deposit nickel weld metal in a series of dots. A stream of air quenches the electrode, keeps the weld cool, and limits heat penetration. No preheat or postheat is necessary.[52]

Stress relieving may be necessary for machining or dimensional stability,[3] but usually the deposition of an extra bead to be later machined off will be sufficient to anneal the underlying layers,[16] but not to stress relieve the whole welded area.

A successful weld can be quite simply produced if the above precautions are followed. The process has been so successful, in fact, that it has occasionally been used in fabrication where the joint is not under excessive restraint. For example, steel supporting bars have been welded to the base of a stock turret of a switch box [16] by this method, and welding of gray iron burner parts has eliminated bolting and gasketing steps previously required.[37] It has also been suggested[14] that the foundryman might break down a complicated casting into simpler components, cast them separately, and assemble by nickel welding as has been done in the case of silver soldering.

Acknowledgment

The author desires to thank the following companies for their courtesy in supplying the photographs appearing in this section of the article: Linde Air Products Co., New York; Air Reduction Sales Co., New York; All-State Welding Alloys Co., New York; American Cast Iron Pipe Co., Birmingham, Ala.; The American Brass Co., Waterbury, Conn.; The International Nickel Co., New York; and Westinghouse Electric Corp., Pittsburgh.

NOTE: The complete bibliography will be published with the final section of the article.

SUMMER TRAINING PROGRAM FOR FUTURE FOUNDRYMEN

Harry E. Gravlin, center, assistant plant manager of Ford's Dearborn Iron Foundry, discusses a casting with John Alstetter, Ohio State University and Oliver Perry, University of Alabama.

EACH SUMMER since the inauguration of the Foundry Educational Foundation in 1947 has seen a substantial increase in the number of engineering students who have spent the customary vacation months working in foundries. Manner of handling the students and integrating them into plant operations has been handled by each plant in its own way. Combined experience of all participating plants is developing a pattern which serves as a useful guide to other companies. First summary of these experiences was presented at the 1950 A.F.S. Convention in a paper, *"The Engineering Student and Summer Foundry Work,"* by N. J. Stickney, then in the metallurgical engineering department of the University of Wisconsin. Other experiences were described in the March 1950 issue of AMERICAN FOUNDRYMEN by Wyllys G. Stanton, associate professor of industrial engineering, Ohio State University, in an article entitled *"Summer Foundry Work for Student Engineers."*

William E. Goudey, general superintendent, cylinder block job, explaining pouring car operations to Emil Chirila, student from Case Institute of Technology.

Most recent program reported was conducted during the past summer by the Ford Motor Co., Dearborn, Mich. General principles and methods used lend themselves to any kind or size of foundry and the program is believed to be a milestone in the preparation of engineers for careers in industry.

Ford foundry management arranged with the Foundry Educational Foundation to have 30 to 35 students assigned to a program with the following major objectives:

1. To provide candidates for the supervisory and technical foundry staff.
2. To introduce prospective candidates to the mode of operation and policies of the Ford foundry.
3. To determine whether the individual student summer worker would welcome a career opportunity with Ford and concurrently if their qualifications were such that the Ford organization could accept them.
4. To develop a summer work program for engineering students to implement the above objectives.
5. To develop and introduce a foundry training program for engineering graduates integrated with the over-all Ford Motor Co. training policies.

Members of the group were selected by Ford educational representatives and brought to Dearborn for interview prior to acceptance. The number was restricted the first year, but could increase in the future.

Oliver Perry and John Alstetter learns about crankshaft pouring from General Supt. James Garrett.

Soon after the end of their college terms, the summer student workers reported to the plant where they were guided through the required employment procedure and then turned over to foundry management. Plant Manager E. C. Jeter and Assistant Plant Manager H. G. McMurry assigned them to Ted Beauregard, foundry personnel representative, as a group for the term of their employment. The procedure gave the students a direct representative of management with whom they could discuss problems and obtain help if needed in maintaining good relations with the regular staff. Assistance in locating rooms for the summer was also given through this arrangement.

Students Assigned Two or More Jobs

Students were not placed on definite schedules of movement through the foundry. Some degree of effective performance was necessary to make their employment practical and frequent moves would not permit development of required proficiency on any one task. Most of the students were assigned two or more different jobs during the summer, thereby gaining some movement through the plant. Students working for the second summer were placed in new departments and frequently according to their choice.

Eighteen meetings were held throughout the summer to acquaint the students with over-all operations and policies. They attended these meetings on their own time except where plant tours required longer periods in which case time off from regular shift work was allowed. Meetings were conducted by management and engineering representatives and by specialists in various phases of production.

Meetings scheduled were: Introduction, Company Organization, Cylinder Block Movie, Melting, Sand Control, Core Making and Molding, Engineering, Accounting, Quality Control, Production Control, Management Relations, Motor Assembly Plant Tour, Dearborn Assembly Plant Tour, Casting Machine Plant Tour, Supervisory Training, Blast Furnace Tour, Labor Relations, and Farewell.

Safety switches require use of all four hands as Daniel Cytrynowicz, Penn State, left, and John W. Wasem, Ohio State, right, mold drag for valve chamber cover.

Successful performance during the summer marks the young men as candidates for the special foundry field training program inaugurated this year. First group through the program consists of seven men representing Michigan State College, Illinois Institute of Technology, Missouri Mines, and Massachusetts Institute of Technology. The program they follow provides a definite training and work schedule with move-

Summer work students and Ford supervisory personnel. Kneeling, left to right, are: W. Throndsen, University of Wisconsin; O. Perry, University of Alabama; D. Cytrynowicz, Penn State; A. Charneski, Missouri Mines; B. Amos, University of Illinois; T. Taylor, Massachusetts Institute of Technology; T. Moorman, Notre Dame; B. Hull, Howard University; R. Wimmert and J. Garrett, Purdue; C. Schoettler, University of Wisconsin; and G. Lockwood, Michigan State. Standing, left to right, are: T. Beauregard, Production Foundry personnel representative; E. Chirila and F. Nelson, Case Institute of Technology; W. Griffin, Penn State; J. Alstetter, Ohio State; H. Drummond, Howard University; W. Dieters, Michigan State; K. Elbaum, Missouri Mines; J. Fackelman, Case Institute of Technology; E. C. Jeter, Production Foundry plant manager; W. Kahl, MIT; F. C. Riecks, Cleveland Foundry project engineer; E. Skorl, Case; E. Duda, Cornell; R. Lundberg, Case; R. Lenhart, Ohio State; J. Lynch, MIT; J. Wasem, Ohio State; L. Hanis, M. Basche, and G. Poiver, MIT; and W. Harper, Ohio State. Not shown are Prof. C. W. Morisette, M. Zevin and W. Gloe.

Left—Bernard S. Hull, Howard University, making tractor flywheel strainer cores on a ram-up jolt machine. Center—Germaine C. Lockwood, Michigan State College, clamps cope and drag of a cylinder block mold. Right—Frank G. Nelson, Case Institute of Technology, uses rubber mallet to assemble deep jacket core box.

ment through the major sections of the foundry departments.

Satisfaction with the program is shown in the comments of some of the Ford supervisory personnel.

"On-the-job experience is an invaluable asset," states E. C. Jeter, plant manager. "These young men have rubbed elbows with actual foundry conditions and have acquitted themselves most creditably."

Assistant Plant Manager H. G. McMurry says, "It is a distinct pleasure and a profitable one to have had these boys working in our plant. Their grasp of the working situation and eagerness to understand our whole operation marks them as an outstanding group."

Comments of W. E. Goudey, general superintendent, cylinder block job, are: "Our experience on the cylinder block job with these young fellows has been a good one. We find them alert and quick to learn every operation. We all feel that men of this caliber are more than welcome here at the Ford Motor Co."

According to Tony Cucinella, No. 1 Core Room, "These men are in a good position as future managerial material to acquaint themselves with labor's problems as well as those of management. We welcome programs of this sort in the belief that work experience they receive will benefit labor and management."

Viewpoint of an educator is given by C. W. Morisette, assistant professor, Pennsylvania State College, who worked in the Ford foundry during the past summer: "In my opinion, the Foundry Educational Foundation summer work training program for college students is a major contribution to the foundry industry. It enables these men to secure the practical experience to decide that the foundry offers many opportunities for a career. There is no substitute for practical work in training program.

"The Ford Motor Co. Production Foundry offers much valuable practical and related information for the college men to take back to the class room. To experience the different work situations and to observe and evaluate the varied molding, coremaking, melting, and handling methods, together with the semi-weekly meetings, is excellent training for potential key foundrymen."

Observations of F. C. Riecks, former manager of Ford foundry operations and currently Cleveland Foundry project engineer, are expressed in this month's editorial on page 27.

1951 A.F.S. Apprentice Contest Entries Required To Meet Minimum Standard

LAUNCHED SEPTEMBER 15, the 28th Annual A.F.S. Apprentice Contest is governed by a new "salable casting and pattern" regulation which requires entries to meet minimum standards for national competition. The contest is open to all apprentices in the United States, Canada, and Mexico taking regular training courses of not less than three years' duration and who are not over 24 years old on the day they prepare their entries. For veterans the age limit is 24 plus the length of service in the Armed Forces.

The new regulation states that "entries must be salable castings and patterns, and to qualify for prizes, the first prize winner must rate a score of 88 points minimum, the second prize winner 85 points minimum, and the third prize winner 76 points minimum, in the national judging of contest entries." Complete regulations governing the contest and other information can be obtained from J. E. Foster, American Foundrymen's Society, 616 S. Michigan Ave., Chicago.

As in last year's contest, there will be five divisions —Metal Patternmaking, Wood Patternmaking, and Gray Iron, Non-Ferrous and Steel Molding. Patterns for the molding divisions and blueprints for Wood Patternmaking are supplied through A.F.S. Headquarters. For Metal Patternmaking, blueprints and rough aluminum castings will be supplied.

Contest entries will be judged early next April and prizes of $100, $50 and $25 will be awarded to winners of each contest division.

Questions and Answers — THE ROUND TABLE

How To Salvage Brass Grindings

In our works we produce brass grindings which are difficult to melt. It will be appreciated if you can tell us about a good method whereby this material can be melted in a crucible or electric furnace with the smallest possible loss. Is it true that good results can be obtained by making briquettes from the grindings and some flux like borax?

The reduction of recovered brass grindings to solid material is a task that would not ordinarily be attempted by any but the largest producers of such material or by foundries so isolated as to have major difficulties in securing raw materials.

However, smelting of grindings should be possible for any foundry having crucible furnaces, even though it would probably be unprofitable except in large quantity.

Grindings will vary widely in composition but will normally consist of: the metal being ground, oxides of the metal being ground, silica particles, and particles of the grinding wheel material—normally aluminum oxide or silicon carbide.

In order to reduce the grindings to a homogeneous melt the following must be accomplished:

(a) Melting point of metal must be exceeded.

(b) Metallic oxides must be reduced to metal and must be prevented from reoxidizing.

(c) Non-metallic materials must be reduced to a fluid slag, lower in density than the metal.

(d) Time enough must elapse to allow settling and agglomeration of the finely divided metal particles.

These can be accomplished quite simply in a crucible furnace. The temperature is of course easily attained. The metallic oxides can be reduced by carbon or by carbonaceous gases and the slag can be made fluid by the addition of soda-ash (Na_2CO_3). The quantities of each material required will depend on the grindings used. As a starting point, we would suggest the following: 100 lb grindings, 8 lb coal dust or coke dust, and 10 lb soda ash.

These materials must be intimately mixed. A fairly good job could be done by repeated hand turning with a shovel but a barrel mixer or a small concrete mixer would be preferable. After mixing, fill the crucible to be used, cover with an extra ½ in. layer of soda ash, and heat in the furnace.

Some care will be required as the charge may show a tendency to foam badly unless heating is very slow. Heating should continue until the charge is liquid throughout. Finally, the complete charge may be poured into chill molds and the slag removed after freezing; or the slag layer may be removed from the liquid metal before pigging.

Undoubtedly, the charge suggested will not be the most economical. The quantity of soda ash should be adjusted to the least amount that will give a fluid slag, while the coal or coke should be decreased to the amount required to give clean metal. The soda ash slag will be quite corrosive to crucibles, but if too little is used to produce fluid slags, metal losses by entrainment will be high.

Procedure for rocking, indirect-arc furnace melting will be quite similar except that some method of agglomeration of the mixed charge is desirable. It should be possible to make pellets of the charge by rolling it in a drum (a small cement mixer with the blades removed) while a small amount of water is sprayed in. In this case the addition of some sodium silicate with the water may be required to serve as a binder for the pellets. After air-drying, the pellets may be charged into the furnace for smelting.

Good Babbitting Practice

Can you give me any suggestions for fluxing babbitt and for doing whatever is necessary to eliminate gas holes? The holes show up after machining the journal bearings which are used for railroad freight and passenger cars. Composition of the bearing metal is: copper, 0.11 per cent; tin, 3.57; lead, 88.64; zinc, none; antimony, 7.58; iron, 0.01; and arsenic, 0.05.

Babbitt metal, of the composition given, should not require fluxing of any kind. If slush or dross does form on the surface of the metal, it is advisable to let the melt set quietly at temperature for a few minutes and remove the slush or dross from the surface of the melt with as little turbulence or stirring as possible.

If it is felt that fluxing is necessary due to an excessive amount of return metal which must be remelted and which may contain grease and dirt, there are a number of prepared fluxes on the market which help to free particles of metal that may become entrapped in grease and dirt.

Other types of individual fluxing are used for various purposes but only in a refinery. These special fluxing treatments which are designed to remove intermetallic compounds are not recommended for use in babbitting shops.

Holes which show up after machining are caused by

too low a casting temperature or improper pouring of the metal where there is excessive turbulence with entrapped air. Using a correct pouring temperature and pouring the metal quietly, without turbulence and entrainment of air, will overcome this condition.

H. L. Smith, *Exec. Tech. Eng.*
Federated Metals Div.
American Smelting & Refining Co.
Pittsburgh

Desulphurizing With Soda Ash

We run one cupola 16 hours a day and another five or six hours, both with front-slagging spouts. We desulphurize in a forehearth using soda ash. Under reasonably good slag separation is there any real value to periodic skimming of slag from the forehearth? Is occasional slagging beneficial to the reduction of sulphur in the iron?

Even though the front-slagging cupola is efficient in eliminating most of the slag from the iron before it enters the forehearth, the soda ash used for desulphurization is progressively spent as a result of the reaction with non-metallics in the iron, as well as with the forehearth lining. The effectiveness of the soda ash is primarily dependent upon alkalinity of the slag and upon the amount of sulphur which has reacted with the soda ash.

To achieve maximum effectiveness, it is desirable to remove part of the soda ash slag at regular intervals, usually just prior to the addition of fresh soda ash. This maintains the alkalinity and activity of the soda ash slag at a reasonably constant level, insuring maximum effectiveness and uniformity in removal of sulphur. In most forehearth or teapot type ladle designs, part of the slag can be eliminated relatively easily by tilting the ladle so part of the slag runs over the side.

For maximum efficiency, the iron in the forehearth or bull ladle should remain in contact with the soda ash slag approximately 20 minutes. To achieve this the forehearth should be able to hold the volume of metal which can be melted in the cupola in 20 minutes. The usual quantity of soda ash used for desulphurization ranges from two to 12 lb per ton of metal being treated.

Spinning Pipe Cores

In two or three months we will go into soil pipe production. Can you give us some information about the operation of the machine which forms cores with a blade? What sand mixture should we use? How much string should be put on the arbor? Is a sand thickness of only one-half inch right?

The principle of the green sand core machine, as used in making cores for pipe, is to allow the sand to fall from a height of four to five feet through a V-shaped hopper and onto the full length of an arbor that is rotating on rubber rollers. As the sand builds up on the arbor, the core knife strikes off the excess and forms the shape of the core. The knife should be installed in such a way that adjustments can be made at any time to insure the proper amount of sand on the arbor.

A sand that has proven very satisfactory for this type of core has the following physical characteristics: permeability, 100-110; moisture, 5.0 per cent; green compression, 2.5-3.0 psi; dry compression, 15.0-22.0 psi; clay, 8.0 per cent; and A.F.S. grain fineness, 80.

This sand was obtained by the following mix: 1200 lb sand (3.0 per cent clay, grain fineness 64), 300 lb sand (20.0 per cent clay, grain fineness 100), 300 lb burnt core sand and 8 lb southern bentonite.

Southern bentonite is the logical binder to use, due to the low dry compression and good collapsibility. The sand should be just strong enough to insure against core drops. This will facilitate arbor removal.

If the core machine is operating properly, the only string that should be required is that used in forming the bell section of the core. This is applied for several rounds as the core is being formed on the machine. The proper amount will have to be determined by trial and error, as it will vary with the core size and sand mixes. String on the body of the core may be eliminated if the arbor is brushed or sprayed with a wash (suspension of 2 per cent western bentonite in water) and the excess blown off.

The thickness of the core sand on the arbor should be just enough to prevent chilling of the metal. The arbor should be properly vented to allow the steam and gases to escape.

Fred C. Barbour, *Chief Met.*
McWane Cast Iron Pipe Co.
Birmingham, Ala.

Zircon Sand For Critical Castings

As manufacturers of centrifugal and bore-hole turbine pumps we are required to make various bushes and impellers in gun metal. We prepare the molds in ordinary foundry sand varying in grain size from 40 to 200 mesh. For cores we use special sand screened to between 70 and 100 mesh with linseed oil as a binder. We have to pour at a high temperature to avoid cold shuts in the castings and find there is too much penetration of metal into the sand. Kindly let us know whether we can avoid this by use of any special wash for molds and cores, and suggest such a wash.

In our experience, we have not found any special mold or core coating that will prevent the condition you encounter in the type of casting and alloy mentioned. We have obtained the best results by the use of zircon sand on all of our pumps, runners, and impellor type parts in both gun metal and the high tin straight bronze. Our inside cores are made wholly of zircon sand and molds are faced with zircon at critical areas, if any.

The zircon can be recovered and used again if care is taken in shaking out. We recover about 80 per cent of the sand and burn off all combustibles at about 1380-1470 F before using again. Normally it is unnecessary to use any dressing on zircon cores or molds. The cores, properly made, do not burst; there is no veining or feathering; and burn-in is reduced materially or eliminated. Cores are readily removable.

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Feeder Division
Westinghouse Electric Corp.
East Pittsburgh, Pa.

FOUNDRY PRACTICES FOR ALUMINUM ALLOYS

G. H. Bradshaw
Master Molder
Philadelphia Navy Yard
Philadelphia, Pa.

FOUNDRY TECHNIQUE required to produce good aluminum castings is basically the same as is required where any type of metal is cast. Principles of founding must be understood and a definite procedure outlined and followed.

Melting: Aluminum can be melted in any of the furnaces generally used in foundries. These are: direct flame furnaces, such as air furnaces or reverberatory furnaces; indirect flame furnaces, gas, oil or coke fired; electric furnaces where crucibles are used; and indirect rocking furnaces. Of these the indirect flame furnace is most desirable because it can be readily controlled.

Aluminum, like many other metals during melting, will readily absorb furnace gases, which will affect adversely the quality of the castings produced. These gases include hydrogen, hydrocarbon gases, and water vapor. Care should be taken to see that the charge going into furnace, where machine shop scrap or returns are used, is free from oil or other contamination. Ingots and scrap should not be stored outside in the weather as they will pick up moisture and, if used in that condition, castings may be full of pin holes. This material should be pre-heated or dried before using.

Aluminum readily combines with oxygen, but this is not too detrimental as it improves the corrosion resistance of a piece of aluminum. Oxides become a problem when a melt is overheated or when some agitation has taken place during the melt, forming excessive dross. As the specific gravity of these oxides is nearly the same as aluminum they are not as easily separated as they would be in bronzes or irons.

Crucible Melting

Aluminum can readily be melted in graphite or silicon-carbide crucibles. These, as in all well regulated foundries, should be kept clean to avoid contamination. Some foundries use special cast iron crucibles. These require special care to prevent iron pickup during melting. Generally they are coated with a wash made with powdered talc or crushed mica mixed with water and applied to crucible when fairly hot. Some foundrymen add sodium silicate to the wash to increase its bond.

Temperature control is very important in the melting of aluminum. High temperatures increase the grain size of the metal. Overheated metal suffers from excessive gas absorption. Temperature should be regulated so molds can be poured at lowest temperature possible without danger of misruns.

Unlike some other metals aluminum does not undergo any clearly defined color changes, either in its liquid or solid condition. Therefore it is not possible to judge temperature by color or by eye—it is necessary to use a pyrometer.

NOTE: This article is excerpted from a lecture given as part of last year's 20-week Foundry Course, sponsored by American Foundrymen's Society Philadelphia Chapter.

Fluxes: Fluxes are used to remove oxides and gases from the melt. If melting practice is good, none or very little is required. Fluxes should be added when the desired pouring temperature has been reached, or perhaps 50 to 75 degrees higher. Fluxes generally are aluminum chloride and zinc chloride which dissolve and form gases at metal temperature. Some contain sodium silicofluoride and sodium chloride, or potassium chloride and cryolite. Chlorine gas or dry nitrogen may be injected into the metal through immersion tubes and bubbled through the bath.

Molding: Many of the common molding practices can be applied to the casting of aluminum. Some of the alloys require special care and techniques because the foundryman is dealing with low-temperature metal. Burning-in or fusing of sand to castings is not a problem. Sand with a good permeability and bond, one that will give a smooth casting, can be used. This may be a natural sand or a synthetic sand, depending on shop practice and the sand conditioning equipment available.

Gating: Progressive solidification is as important in aluminum alloy casting as in other alloys. The metal farthest from the gate should begin to solidify first with solidification progressing toward the risers and gate. Some foundries use multiple gating to achieve this. Such gating allows metal to be poured at a lower temperature and also enables it to enter the mold cavities more smoothly. This reduces agitation and tends to eliminate the formation of dross during the pouring of the mold.

Where there are heavy sections or bosses, risers adequate to feed these sections must be used. If this is not possible chills must be used; these can be of cast iron, steel, or carbon. Carbon chills absorb heat more readily and allow gases to escape through them as they are somewhat porous.

Summary: Defects which may be found include dross inclusions, shrinkage, porosity, cracks, and where heat-treated—distortion. Dross is caused by improper gating and pouring. Shrinkage is caused by improper feeding or lack of risers or chills, or lack of solidification sequence. Surface shrinkage is caused by high pouring temperatures, hard ramming, and excessive moisture in the sand. Pinhole porosity is generally found beneath the skin surface and is caused by gas absorbed during melting, hard ramming, wet sand, and low permeability. Cracks are caused by excessive resistance to normal contraction of the casting during solidification and cooling.

New, Smaller A.F.S. Pins Available

Contrasted here in actual sizes are the old A.F.A. pin and the new, smaller A.F.S. pin, reduced in size by popular demand of members of the Society. The new 3/8 in. diameter pins will be traded for the old A.F.A. pins at no extra cost or are available at $1 each from A.F.S. National Office, 616 S. Michigan, Chicago 5.

SLAGGING PRACTICE—A MEANS OF CUPOLA CONTROL

Thomas F. Hart

THE SUBJECT OF SLAGS is wide and complex, and this discussion is intended only as an introduction to an aspect of cupola control that has been disinterestedly dismissed by many foundrymen. The formation of a slag in the cupola, as a rule, has been looked upon as a necessary evil; the fact that it has an important bearing on the quality of the metal produced has generally been overlooked.

In the past, and even at present, the principal objective has been the production of a slag fluid enough to flow from the cinder notch without regard to whether it may be otherwise satisfactory.

Slag is the term applied to the fused, semi-liquid, glass-like mass formed by the action of a flux upon the ash of fuel, the oxidized impurities in a metal, and the particles of foreign matter introduced into the furnace during charging.

Slags consist usually of two or more silicates in which other substances such as metallic oxides, eroded furnace linings, and highly refractory materials may be dissolved or held in suspension.

In cupola practice the slag consists mainly of calcium silicate, but with dolomite in the charge a combination of magnesium and calcium silicates results; lesser amounts of iron, manganese and aluminum oxides as well as traces of alkalies are also found.

Determine Slag Character

Chemically, slags correspond somewhat to the salts of wet chemistry in that they result from the neutralization or partial neutralization of basic and acid materials. Depending upon the amounts of basic and acid materials present a slag may be basic, acid, or neutral in character. Some metallurgists consider the sum of silica and alumina as the acid constituents of the slag, and take lime plus magnesia as the basic ones; others favor the assumption that alumina plays a neutral part and use the silica as the only acid.

In cupola operation alumina is nearly always present, the amount varying between 5 and 25 per cent; much of the conflict of opinion has resulted from the fact that alumina possesses both acid and basic properties and consequently tends to act as a stabilizer, maintaining somewhat the equilibrium between acid and basic constituents.

With highly siliceous slag the tendency is toward basicity in behavior, and in highly basic slag this tendency is reversed in the acid direction, the alumina acting as a neutralizer of lime and magnesia. However, since alumina is relatively weak in the properties of either base or acid the assumption that it plays a neutral part suffices for cupola slags which, although acid in character, are not highly siliceous in good practice.

Fusion in the cupola of coke ash, oxides present in the charge, adherent sand from foundry returns, eroded lining and oxides of silicon, manganese, and iron, and clay formed during the melting process, result in a viscous slag, which will not run fully from the furnace and prevents easy flow of the charge through the melting zone. This viscous slag blankets the coke surfaces in the zone immediately above the tuyeres and retards the rate of combustion. Since it solidifies at a comparatively high temperature it is rapidly frozen by the incoming blast, forming a part-bridge over and under the tuyeres, which eventually tends to block off the cupola, slows down the melting rate, and leads to low tapping temperatures, accompanied by excessive oxidation of silicon, manganese, and iron.

To render this natural slag more fluid, and as well to increase its volume and refining value, fluxing agents such as limestone, dolomite, fluorspar, and sodium carbonate are used; the latter two are seldom used alone, but more usually as additional liquifiers.

This accelerated formation of a larger volume of low viscosity and chemically active slag results in a constant flushing of the coke in the combustion zone, thus allowing a more intimate contact of blast and coke, and droplets of iron and incandescent fuel surfaces. The establishment of such conditions promotes better melting practice, and increases well and tapping temperatures.

Addition of a flux to the charge also accelerates the conversion of carbon dioxide to carbon monoxide by virtue of the fact that larger surface areas of the coke are available, at the faces of which the combustion reaction

$$CO_2 + C = 2CO$$

takes place. The acceleration of this reaction restricts the melting and superheating zones to a shorter, hotter area, giving a higher melting temperature and re-

A spoon sample of slag is taken during slagging-off.

NOTE: This paper is reprinted from *The Australian Foundry Trade Journal*, May, 1950.

ducing the time of exposure to the blast of the descending droplets of metal in passing down to the well zone, thus minimizing oxidation losses. This reduction in melting losses is also assisted by the tendency of the droplets of iron to become surrounded by a protective coating of reactive slag as they trickle down through the bed coke.

One of the main reasons for an early and rapid formation of hot fluid slag has its origin in the effect of the blast on the metal in the well zone. Immediately above and adjacent to this zone is the tuyere zone which, when considered in its true light, is actually a cooling zone for the metal on its downward path.

Here the blast air has had little if any time to react with the coke and consequently is relatively cold. In addition, there is a marked tendency to deflection of its passage, bringing about a marked cooling effect on any metal accumulated in the well. If slag has been rapidly formed it makes an insulating blanket on the top of the metal and protects it from the cooling air currents, and effectively increases the tapping temperature by some 100-125 F; particularly is this evidenced in the first tap.

Another feature of this slag blanket is its action as a filter, holding back impurities, serving as a solvent for entrained oxides, and exacting a desulphurizing action on the metal which passes through to the well.

A point well worth noting at this juncture is that metal tapped from an improperly slagged or non-slagged furnace will contain more entrained slag particles than metal from an efficiently slagged furnace.

Flux Needed in Short Heats

In many foundries heats of short duration are not slagged off, or in many instances little or no limestone or other flux is added to early charges. This is to be deplored even on very short heats. The consequences are: viscous slag, poor blast distribution, lower melting rate, lower tapping temperature, partial or complete bridging, increased coke consumption, higher oxidation losses, higher sulphur content, harder irons, dirtier metal, and coldshuts and misruns resulting from lower pouring temperatures.

Surely the beneficial effect of a fluxing agent, used in its correct amount, more than outweighs the detrimental effect on melting conditions and the properties of the resultant metals, particularly in the production of specification irons.

The actual amount of limestone required to flux each furnace charge is rather difficult to state due to varying shop conditions and lack of uniformity in coke ash contents, together with a similar lack of uniformity in cleanliness of scrap supplies which most foundries have been forced to use in increasing amounts due to the shortage of pig iron.

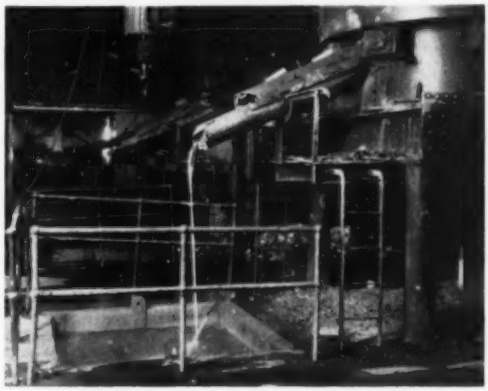
However, as a basis of operation, it is general with Australian cokes to use approximately 25 per cent, by weight, of the fuel charge. (EDITORS NOTE: The A.F.S. HANDBOOK OF CUPOLA OPERATION recommends 20 per cent, with three or four flux charges in the bed and none in the last two or three cupola charges.)

The modern trend is to use at least two such charges of limestone on the bed, not so much to flux the bed but mainly to hasten the formation of a slag blanket in the well zone. In many cases, due to the absence of sufficient amounts of ash and oxidized material, a pronounced attack on the refractory lining occurs, but this may be overcome by the addition of siliceous rock or crushed cupola lining in amounts approximating 25 per cent, by weight, of the limestone charged. These amounts, of necessity, will have to be varied from shop to shop, and should be altered to obtain a slag conforming to the following analysis:

Silica, per cent	25–45
Alumina, per cent	10–20
Lime-magnesia, per cent	30–40
Iron oxide, per cent	5– 8
Manganese oxide, per cent	1– 4

It is realized that many foundries are not equipped to carry out determinations of this nature. Still, in the absence of this facility the slag color will serve as a criterion of practice, which will be discussed later.

In the event of a slag of insufficient fluidity being formed, an addition of fluorspar or sodium carbonate



Slag disposal in this foundry is accomplished by removable slag basins installed at rear of cupolas.

even in small amounts is very beneficial. Small quantities such as one part to ten parts of limestone markedly increases fluidity. In the case of sodium carbonate a dual purpose will be served as a reduction in sulphur pick-up is brought about by virtue of its high alkalinity. This addition of sodium carbonate, however, can be reduced to less than half after the first two charges without ill effect.

The effectiveness of small amounts of sodium carbonate and fluorspar is widely accepted as being due to: 1—their tendency to melt higher in the stack and, in trickling down over the limestone and coke, accelerating fluxing and combustion reactions, producing a high temperature and more active slag; 2—they possess the power of dissolving entrained particles of solid matter, which are relatively insoluble or slowly soluble in normal lime-magnesia base slags, and which decrease the mobility of the slag or its viscosity.

In regard to slag composition, the following points are worth noting:

1. With silica at 35-40 per cent maximum sulphur removal is obtained. Higher silicas reduce absorption.

2. The absorption power of a slag is increased at high temperatures.

3. Increased iron oxide content reduces sulphur absorbing capacity of slag.

4. Small additions of sodium carbonate increase sulphur absorption far in excess of its proportion in the slag. The effect is most pronounced with high steel melts.

5. High lime slags increase lining erosion.

It is often found that the slag produced during the melting of high steel scrap charges is frothy in nature and the resultant metal is lower in carbon than normal. Slags of this type are generally high in iron oxide content and deficient in lime. An increase in bed height and/or coke ratio, and possibly an increase in limestone is, as a rule, effective in reducing this condition. With high steel charges the iron oxide content of the slag often exceeds 10 per cent, and on this account it is usually necessary to increase limestone to as much as 35 per cent of the coke charge by weight.

Where facilities are not available for more complete control of slagging practice slag color affords a fair indication of its composition and a guide to conditions existent in the cupola, as the various constituents affect the color of the slag materially. A black slag is indicative of excessive blast pressure, low bed, or the presence of large quantities of rusty or oxidized scrap in the charge. Insufficient slagging material or high oxidation of iron and manganese results in very dark brown or black slag.

When too little lime or magnesia is present the slag tends to be dark gray. Excess of lime or magnesia shows up as a light gray or cream coloration.

Slag Color Is Guide

Efficient slagging technique is evidenced by a light gray-green or olive-green slag, with a whitish incrustation. Many other variations of these color guides undoubtedly will be encountered, but the constant observer will notice that the iron oxide content of the slag is dependent on both temperature and lime content of the slag. Also, that with constant lime content, iron oxide content (oxidation of charge constituents) will decrease as tapping temperature increases.

By the taking of spoon samples at the start of each slag-off the appearance of the solidified sample will further allow a rough estimation of iron oxide in the slag, for a rough relation exists between the iron oxide content and the surface appearance of the sample. As the color turns from white, light brown, dark brown to black an increase in iron oxide will occur.

Alterations in slag condition will serve as an indication of change in bed height, providing correct charging technique and the proper amount of flux have been used.

An increase in bed height is usually accompanied by a loss in slag fluidity, a lighter slag color, a tendency toward the formation of slag wool, bridging due to decreased slag fluidity, increase in metal temperature, with iron showing more open-grained fracture and lessening of chill depth, and an increase in flame at the charging door due to increased carbon monoxide in effluent gases.

A decrease in the bed height will be evidenced by an increase in slag fluidity, darker slag due to higher oxidation of iron and manganese, melting rate will at first materially increase, followed by a gradual drop in metal temperature. Chill depth will increase and a denser fracture will occur; also, a marked variation in the type of oxide-flash or "flicker-break" will take place on cooling.

Summary

The primary requisites of a slag are:

1. It shall not be too costly to produce.

2. Melting point should be reasonably low to obviate fuel wastage.

3. It should not be so viscous as to be a source of trouble and produce inefficient melting.

A fluid slag:

1. Allows equitable distribution of blast air, promoting combustion.

2. Permits the iron to absorb carbon.

3. Gives a clean drop.

4. Reduces slaghole trouble.

5. Lowers losses due to entrapped metal globules.

Slags which have been properly formed materially aid the process by protecting the molten metal from blast action. On account of their fusibility, chemical activity, dissolving power, and low density, slags furnish the means by which impurities are separated from the furnace.

They perform other important functions, such as serving to blanket the molten metal from blast impingment, and because of their high solvent power can also be used as a potential medium of quality control. Further, in cupola practice the importance of slags cannot be overstressed, as they are the only positive medium for sulphur removal.

The purpose of fluxes is to improve cupola melting conditions and assist in the refining of the metal. They also serve to maintain fluidity at lower temperatures and facilitate the separation and flow of slag through the slaghole.

The trend of modern practice is toward the use of a heavy charge of flux and an additional liquefier on the bed and early charges, thereafter reducing the flux to a minimum required for smooth operation throughout the heat; keeping in mind that the effect of the flux on the slag lining is secondary to its effect upon the production of quality castings.

1950 Convention Attendance List Now Available To General Public

Registered Attendance List for the 1950 A.F.S. Foundry Congress and Show, prepared initially as a courtesy to exhibiting companies, is now available for general distribution. Already mailed gratis to exhibitors, the limited supply is now being sold to non-exhibitors at $10.00 per copy. The list is arranged geographically and gives company name and address, and title of men listed. Included are representatives from foundries all over the United States, the District of Columbia, the Canadian provinces, Mexico, and over 15 countries outside of North America.

The 1950 Registered Attendance List can be ordered from A. A. Hilbron, Convention and Exhibits Manager, American Foundrymen's Society, 616 S. Michigan Ave., Chicago 5, Ill.

COLORIMETRIC DETERMINATION OF NICKEL IN BRASSES AND BRONZES

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A VERY RAPID AND ACCURATE dimethylglyoxime colorimetric procedure for the determination of nickel in brasses and bronzes is described in this article. Iodine (G. Haim and B. Tarrant, *Ind. Eng. Chem.*, Anal. Ed., 18, 51, 1946) is used as the oxidizing agent.

Apparatus and Reagents

A photoelectric colorimeter with a test tube absorption cell and a 540-millimicron filter is employed.

Ammonium Citrate Solution: Dissolve 250 grams of citric acid in 1 liter of water, and add 250 ml of ammonium hydroxide (28 per cent). Dilute to 2.5 liters with water.

Iodine Solution: Dissolve 12.7 grams of iodine and 25 grams of potassium iodide in 25 ml of water. Dilute to 1 liter with water.

Ammoniacal Dimethylglyoxime Reagent: Dissolve 0.8 grams of the sodium salt of dimethylglyoxime in about 200 ml of water, add 145 ml of ammonium hydroxide (28 per cent), and dilute to 2.5 liters with water. This solution should be made up fresh every 2 weeks.

Procedure

Dissolve a 1-gram sample in 25 ml of nitric acid (1:1), filter off the metastannic acid, and electrolyze the copper and lead in the usual manner. Dilute the electrolyte from the copper and lead determinations to exactly 250 ml and pipette a 10-ml aliquot into a 100-ml volumetric flask. Add 10 ml of ammonium citrate solution and 2 ml of iodine solution. Dilute to the mark with ammoniacal dimethylglyoxime reagent and shake. Compare photometrically at 540 millimicrons against distilled water within 10 min. Read the percentage of nickel from a curve or chart prepared by use of standard or synthetic samples containing 0.01 to 2.0 per cent nickel.

The results obtained on three representative National Bureau of Standards samples are shown in Table 1.

Acknowledgment

The authors wish to acknowledge the suggestions of I. G. Slater.

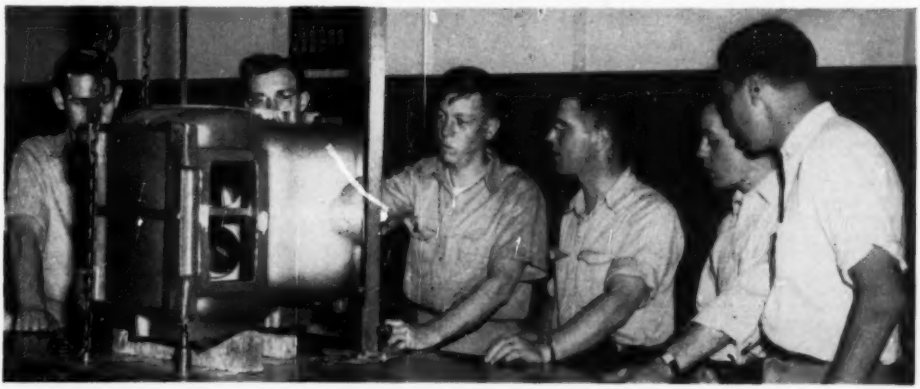
TABLE 1—RESULTS FOR NICKEL ON NATIONAL BUREAU OF STANDARDS BRASS AND BRONZE SAMPLES

Sample	Ni Present, per cent	Ni Found, per cent
52b	0.72	0.72
		0.72
		0.71
37d	0.58	0.58
		0.58
		0.58
62b	0.27	0.27
		0.27
		0.28

*Present address, 3353 Ridge Ave., Philadelphia, Pa.

NOTE: The opinions expressed in this article are those of the authors, and are not to be construed as representing the official views of the Navy Department.

Lynchburg Foundry Is Host To Washington And Lee Student Engineers



Among the many groups who visited the modern plant of the Lynchburg Foundry Co., at Lynchburg, Va., during recent months were these Washington and Lee University students. Watching Cleland Maddox and John Ames of Lynchburg (third and fourth left) demonstrating how crankcase casting is inspected are, left to right, Students B. C. Talley, H. L. Steele, J. A. Connelly and J. J. French. Other visitors who have availed themselves of Lynchburg's "open door" policy toward educational and research groups this year have been Virginia Polytechnic Institute students, Swiss and English foundrymen touring the U. S. after attending the 54th A.F.S. Foundry Congress, and Army ordnance officers from Camp Lee, Virginia.

Letters to the Editor

All letters of broad interest which do not violate A.F.S. policy or good taste are publishable. Write to Editor, American Foundryman, 616 S. Michigan Ave., Chicago 5, Ill. Letters must be signed but will be published anonymously on request.

Section Size and Design

Browsing through AMERICAN FOUNDRYMAN of about a year ago, I re-read the editorial in the September 1949 issue. In it A.F.S. National Director Thomas E. Eagan states:

"Almost all design engineers are willing to cooperate with the foundryman and are receptive to suggestions from him. . . . Many foundrymen are not taking advantage of the opportunity to cooperate with the designer. The cultivation of friendships between the two is always a good policy."

We might add "and good business."

Mr. Eagan's editorial is an incentive for both foundryman and designer to reduce critical points in casting design to minimize the metallurgical and mechanical hazards of the foundryman, inherent in gray ironcasting production.

The purpose of this letter is to call attention to one factor in casting design—section thickness—which, when borne in mind by the designer and reflected in the final contour of the casting, will materially assist the foundry in producing a quality product. The fact that variations in section thickness militate against uniformity of hardness and machinability (unless heat treated) is perhaps somewhat obvious. Uniform hardness and machinability, however, require that definite limits be placed on section thickness. At the minimum permissible thickness of one portion of a casting may be dictated by the thickness of an adjacent section.

The data presented in the accompanying diagram are to illustrate only the effect of section size on the selection of metal for a casting of specific hardness. In presenting these data it is recognized that there are other factors governing the selection of metal and the results obtained therefrom in regard to hardness required at a specified point in the casting. Hardness specifications and tolerance should be on blueprint of light and heavy sections so that inspectors may use the location for testing hardness.

A Brinell hardness specification (187 to 217) insuring good machinability in cast iron was arbitrarily selected and metal secured to meet this variation in three ranges of section thickness. A wedge casting 9 in. long, 1½ in. wide, and varying in thickness from 1 in. at the gate end to a feather edge at the thin end was used to determine the allowable tolerance in section size and to illustrate the resulting hardness if these limits are exceeded. The pouring temperature used in each case was typical for production castings of the same metal. To eliminate the effect of sand properties on the resulting hardness, one green sand mixture of the following properties was used for all metals tested: moisture, 3.3 per cent; green compression, 18.0 psi; and permeability, 75.

In the accompanying diagram, wedges 1, 2, and 3 show the allowable range of section thickness of three irons having different chemical analyses, the shaded areas indicating minimum and maximum thickness permissible if the Brinell hardness limits are not to be exceeded. The wedge designated 4 was made of an alloy iron and is included to illustrate the extreme variations in hardness that will result if consideration is not given in the design of a casting to the effects of section thickness.

The metal from which wedge 1 was cast is satisfactory for the desired hardness range between ¼ in. and $\frac{7}{8}$ in. in thickness. The physical data secured on the 1.2 in. diameter test bars as shown in the tabulation are misleading because the section size of the bar is greater than the cast section size for this metal.

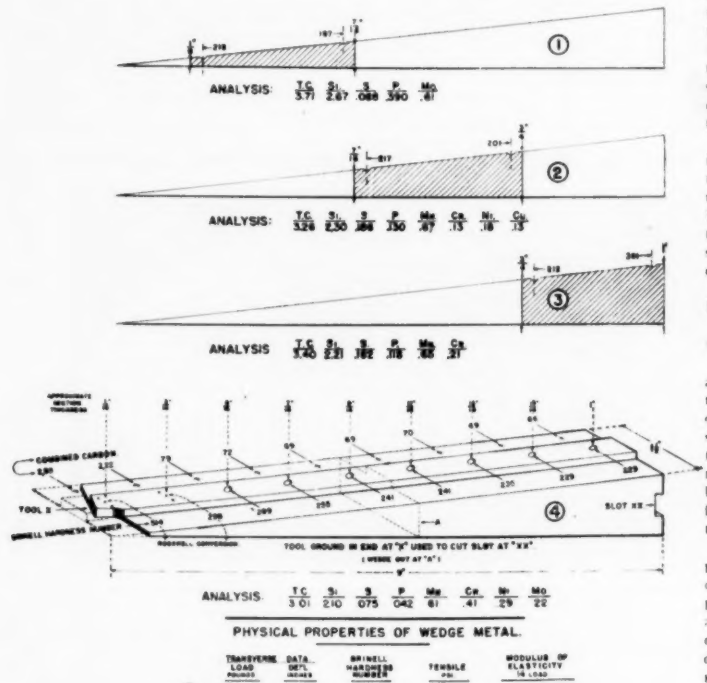
The metal from which wedge 2 was cast is satisfactory from $\frac{7}{8}$ in. to ¾ in.

Metal in wedge 3 is satisfactory from ½ in. to 1 in.

Metal in wedge 4, used where good wear and heavy service are more important than easy machinability, illustrates the danger of thin sections in quality high strength iron castings. The thin edge of the wedge was actually used as a tool to machine a slot in the heavy end. The combined carbon content in the wedge varied from 0.66 per cent in the 1 in. thick section to 2.95 per cent in the $\frac{7}{8}$ in. section.

The metal analyses and the physical properties were determined from 1.2 in. diameter test bars cast to size in dry sand pipe molds from the same ladle of metal as the wedges. All tests were made on as-cast bars. The transverse and modulus data were secured on a 12 in. span. The modulus test bars were machined to 1 in. in diameter for the full length. The tension test bars were machined to standards.

G. W. CANNON,
Muskegon, Mich.


ANALYSIS: TC 3.71 Si 2.67 S .088 P .390 Mo .61
ANALYSIS: TC 3.26 Si 2.30 S .094 P .150 Mn .67 Cr .15 Ni .18 Cu .15
ANALYSIS TC 3.40 Si 2.21 S .102 P .118 Mn .88 Cr .21
COMBINED CARBON
TOOL X
SLOT XX
TOOL GROUND IN END AT "X" USED TO CUT SLOT AT "XX"
ANALYSIS TC 3.01 Si 2.10 S .075 P .042 Mn .61 Cr .41 Ni .29 Mo .22

PHYSICAL PROPERTIES OF WEDGE METAL.

	TRANSVERSE LOAD POUNDS	DATA DEFL. INCHES	BRINELL HARDNESS NUMBER	TENSILE P.S.I.	MODULUS OF ELASTICITY IN LOAD
①	1,760	.11	170	20,400	9,200,000
②	3,480	.17	207	35,000	13,400,000
③	3,140	.12	217	35,200	14,100,000
④	4,760	.18	241	48,400	15,200,000

Specimens showing effect of section thickness and analysis on properties.

WHO'S WHO

K. J. Yonker

Kenneth J. Yonker, co-author with George A. Stolze of *"Special Investment Casting Techniques,"* Page 33, in which he describes methods at Allis-Chalmers Mfg. Co., Milwaukee, is a 1942 graduate of the Michigan College of Mining and Technology . . . Following graduation, Mr. Yonker joined Allis-Chalmers as a metallurgist in the Research department, later becoming Blower and Condenser department metallurgist, and is today applications engineer for the company's Precision Casting section.

G. A. Stolze

George A. Stolze, like his co-author of *"Special Investment Casting Techniques,"* Page 33—Kenneth J. Yonker—is a member of the staff of Allis-Chalmers Mfg. Co., Milwaukee, where he is superintendent of Precision Casting . . . A graduate of the University of Wisconsin, Mr. Stolze joined Allis-Chalmers as a metallurgist in 1942, becoming superintendent of the Precision Casting Section last year . . . He is a member of A.F.S. and ASM.

E. J. McAfee

E. J. McAfee, author of *"Modern Foundry Methods—Plastic Patternmaking for the Small Pattern Shop,"* Page 42, is master patternmaker at the Puget Sound Naval Shipyard, Bremerton, Wash. . . . Long active in the American Foundrymen's Society, Mr. McAfee is a member of the A.F.S. Apprentice Contest Committee and of the A.F.S. Pattern Division's Pattern Manual Committee and is a director of the A.F.S. Washington Chapter . . . Well-known in the patternmaking field, Mr. McAfee is co-author of the Patternmakers' Manual, published by the Patternmakers' League of North America in 1947 . . . A frequent speaker before trade and technical groups, he has contributed many articles on various phases of patternmaking to the trade and technical press . . . He has been with Puget Sound Naval Shipyard since 1916 and last year was awarded the Navy's Meritorious Civilian Citation for his work with plastic patterns, described in this issue.

Man Singh

Man Singh, author of *"India's Mystery Iron Pillar of Qutab, Delhi—Casting or Weldment?,"* Page 49, is proprietor of Greysham & Co., Delhi engineering firm . . . He is holder of an Indian patent on an improved core strainer manufactured by his firm, and three others for producing nodular iron . . . A member of A.F.S. since, 1948, Mr. Singh also holds memberships in the British Cast Iron Research Association, Institute of British Foundrymen, All-India Mfrs.' Association, and Delhi Factory Owners' Federation.

C. O. Burgess

Charles O. Burgess, author of *"Gray Iron—Welding, Joining and Cutting,"* Part I of which appears on Page 50 of this issue, is technical director of the Gray Iron Founders' Society and a frequent and well-known speaker before A.F.S., ASM, ASTM and other technical metals societies on production of high duty cast irons and effects of alloys, inoculants, etc. . . . He has written many articles for the technical press and contributed monographs to the A.F.S. Cast Metals Handbook while serving as chairman of the Handbook Committee . . . Past chairman of the A.F.S. Gray Iron Division, he has served on many technical committees of A.F.S. and is past chairman of the Western New York Chapter of the Society . . . Formerly head of Union Carbide & Carbon Corp. Research Laboratories' Cast Iron and Steel departments, Mr. Burgess has been technical director of the Gray Iron Founders' Society since 1948 . . . His article, Part I of which appears in this issue, will be continued in the November and December issues and constitutes Chapter VII of the forthcoming *Gray Iron Handbook*, published by the Gray Iron Founders' Society.

Leo R. Friedman, author of *"Producing Malleable Cast Iron,"* Page 39, is chairman of the A.F.S. Steel Division's Melting Methods Committee . . . A graduate of the Illinois Institute of Technology in 1936, he has spent his entire foundry career with the Cicero, Ill., plant of the National Malleable & Steel Castings Co., starting as chemist in 1937 and becoming successively chief chemist (1940), assistant metallurgist (1944) and has been plant metallurgist there since 1947 . . . Mr. Friedman is a member of the American Foundryman's Society, Steel Founders' Society of America, American Society for Metals and the Malleable Founders' Society.

Issue Monthly French Foundry Bulletin

Volume 1, Number 1 of the Monthly Information Bulletin of the French Foundry Technical Association (L'Association Technique de Fonderie) was published in Paris this June. Listed in this first issue are proceedings of various technical committees of the Association, new members, technical program for the 1950-51 season; and a brief report of the French Foundry Productivity Team's recent visit to the United States.

Index to Technical Reports Available

Subject index to technological documents issued in Vol. 12 of the *Bibliography of Technical Reports*, is now available, the Department of Commerce's Office of Technical Services announces.

The index enables researchers to locate reports on any subject carried in the Bibliography from July to December, 1949. Subject headings are comprehensive and include trade names where appropriate. Copies of the Index may be purchased from the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C. at $1 each. The *Bibliography of Technical Reports*, issued monthly, lists additions to the OTS collection of foreign and domestic technical reports, now totalling some 150,000 items. Information on any field is available from OTS.

IBF "Proceedings" For 1949 Issued

Annual *"Proceedings of the Institute of British Foundrymen,"* Volume XLII, 1949, is now available. This volume contains papers presented to the 46th Annual General Meeting of the Institute and a selection of papers presented during 1949 at various branch meetings of the Institute.

FOUNDRY Personalities

William B. Given, Jr., for 21 years president of the American Brake Shoe Co., was named chairman of the board of directors of the company at a board meeting held September 13. Mr. Given will be succeeded as president by **Maurice N. Trainer,** formerly first vice-president of Brake Shoe. Mr. Given joined Brake Shoe in 1911 as secretary to the president and, after two

W. B. Given, Jr.

year's service overseas in World War I with the famous "Fighting 69th," rejoined the company as assistant vice-president in 1919. He was named vice-president of the company in 1921 and president in 1929. Mr. Trainer, a graduate of the University of Pennsylvania, joined Brake Shoe in 1916 as an inspector and moved up through

M. N. Trainer

the company's sales departments to become president of the Brake Shoe and Castings Division in 1938. In 1943 he was elected first vice-president and in 1944 became a director. He is also president of Dominion Brake Shoe Co., Ltd.

E. Claude Jeter has been named manager of Ford Motor Co.'s new production foundry under construction at Cleveland. He will be succeeded as manager of Ford's Dearborn Iron Foundry by **Harry G. McMurry,** former plant manager. Mr. Jeter joined Ford shortly after graduation from Clemson College in 1928 as a member of the metallurgical control department and

E. C. Jeter

has since been, successively, a staff member of the experimental department and metallurgical control department, assistant superintendent of the Rouge production foundry, and since early this year, manager of the production foundry and pattern shop. Mr. McMurry was associated with the Buick Motor Div., GMC, Flint,

H. G. McMurry

Mich., from 1927 to 1945, when he was sent by General Motors to Melbourne, Australia, to supervise construction of a modern production foundry—the first of its kind in Australia. Upon his return to the United States in 1949, Mr. McMurry was employed at the Pontiac foundry as assistant plant superintendent, and since February of this year has been assistant manager of Ford's Rouge Production Foundry.

John A. Decker has been named New York district sales manager, and **William J. Kingsley** assistant sales manager of the

J. A. Decker

Bonded Products and Grain Division of the Carborundum Co., Niagara Falls, N. Y. Mr. Decker has been with the company since 1933 and was formerly assistant New York district sales manager. Mr. Kingsley, a veteran of 25 years' service with the company, was previously sales representative for the company in the Boston and Syracuse, N. Y., areas. Other changes announced by Carborundum are: **Thomas Curtiss,** Buffalo district held sales representative, transferred to the Central New York area; **Edgar T. Harris,** to succeed Mr. Curtiss at Buffalo; and **George Dennison,**

W. J. Kingsley

formerly Buffalo district industrial salesman, to be special sales engineering representative for New York, with headquarters in Buffalo.

Carl E. Allen, vice-president of the National City Bank of New York since 1940, has succeeded **Ira A. Wyant** as president of Campbell, Wyant & Cannon Foundry Co., Muskegon, Mich. A founder of the company, Mr. Wyant will continue as a director. Other officers of the organization remain the same. They are: **C. L. Beatty,** executive vice-president; **W. R. Krepps, I. K. McGregor** and **D. J. Vail,** vice-presidents; **R. I. Lindland,** secretary; and **W. R. Hummel,** treasurer. Mr. Allen, a native of Illinois, will discontinue his position with the bank, with which he has been associated since 1926. He supervised the bank's Michigan business for a

Carl E. Allen

number of years. Campbell, Wyant & Cannon was started in 1908 by Mr. Wyant, George W. Cannon and Donald J. Campbell. Mr. Campbell died in 1943; Mr. Cannon retired as chairman of the board in August, 1949. Mr. Wyant had been president since 1947. Company directors are Messrs. Allen, Wyant and Beatty, **G. D. Branston, N. R. Feltes, William S. Lambie, Arthur B. Lawrence** and **Edward A. McDermott.**

Harold S. Falk, president of the Falk Corp., Milwaukee, was the second annual recipient of the National Metal Trades Association's Industrial Achievement Award, made during the Association's 51st Annual Convention, New York City, September 28. Mr. Falk received the award "because of his energetic and forthright efforts on behalf of equitable working conditions, his pioneering in the development of foreman and apprentice training methods, his contributions to the field of industrial education and his help in formulating and supporting the Association's major principle of establishing and preserving equitable working conditions."

Raymond R. Rausch, vice-president of General Electric Co. and formerly production manager of Ford Motor Co., has been elected vice-president and executive assistant to the president of Willys-Overland Motors, Inc., Toledo, Ohio.

(Continued on Page 91)

A. F. S. CHAPTER DIRECTORY

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WESTERN NEW YORK CHAPTER *Secretary,* R. E. Walsh, Hickman, Williams & Co., 32 Eastwood Place, Buffalo, N. Y.

WISCONSIN CHAPTER *Secretary,* J. G. Risney, Risney Foundry Equip. Co., 1307 N. 65rd St., Milwaukee 13.

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OREGON STATE COLLEGE *Secretary,* Leonard M. Preston

TEXAS A & M COLLEGE *Secretary,* R. L. Jones

UNIVERSITY OF ALABAMA

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Plans for the 1951 A.F.S. Convention were launched September 9 when A.F.S. Secretary-Treasurer Wm. W. Maloney, A.F.S. Convention & Exhibits Manager Alfred A. Hilbron and officials of the Buffalo Convention Bureau met with officers and directors of the A.F.S. Western New York Chapter, 1951 Convention hosts, at the summer home of Chapter Chairman A. A. Diebold, Atlas Steel Casting Co. Left: H. Ward Stewart, Jr., secretary-manager, Buffalo Convention Bureau, looks over Western New York Chapter's scrapbook of chapter activities. Center: A.F.S., chapter and Convention Bureau officials. Right: Chairman Diebold, John D. Fulton, Buffalo Convention Bureau and A.F.S. Convention Manager Hilbron take a moment out to relax between planning sessions. (Photographs courtesy John W. Wark, Wark Foundry Supply).

CHAPTER ACTIVITIES NEWS

Meeting to discuss plans for Chicago Chapter's 1950-51 season at the Union League Club, Chicago, September 11, were chapter officers and members of the program Committee. Left to right, standing: Deming H. Lucas, manufacturers' representative; R. E. Kennedy, University of Illinois; Robert F. Hendry, Love Bros., Inc.; Chapter Chairman C. V. Nass, Pettibone Mulliken Corp.; Vice-Chairman W. W. Moore, Burnside Steel Foundry; Chapter Treasurer James Moore, Wells Mfg. Co.; and Secretary George J. Biddle, Illinois Clay Products Co. Seated, left to right: E. E. Henry, Hammond Brass Works; W. W. Balton, Link-Belt Co.; H. K. Swanson, Swanson Pattern & Model Works; B. C. Yearley, National Malleable & Steel Castings Co.; H. G. Haines, Howard Fdy. Co.; R. W. Schroeder, U. of Ill.

Birmingham District

J. P. McClendon
Stockham Valves & Fittings
Publicity Chairman

ONE OF THE BEST ever held by the chapter was the 17th Annual Outing and Barbecue September 16 at Cascade Plunge, Birmingham.

Long before the appointed hour, the crowd began to appear and by serving time the Annual Outing attendance record was broken.

The Entertainment and Menu Committee was composed of E. A. Brandler, Electro Metallurgical Div., Union Carbide & Carbon Corp., chairman; Eugene Welchel, American Cast Iron Pipe Co.; Lipscomb Carl, Sloss Sheffield Steel & Iron Co.; and William J. Bach, Foundry Service Co.

Sports program included Horseshoe pitching, Softball, "African dominoes" and other special features. A delicious plate of Barbecued Chicken, Spare Ribs, Potato Salad, Slaw, Pickles, Sliced Tomatoes and Buns with Iced Tea, Lemonade, Ice Cream and or Beer was served.

Fred K. Brown, Adams Rowe and Norman, Inc., Birmingham Chapter's "Secretary DeLuxe" was here, there

Several hundred foundrymen enjoyed a day of relaxation, sports and a barbecued chicken dinner at Birmingham District Chapter's 17th Annual Outing, held on September 16 at Cascade Plunge, in Birmingham.

and everywhere, greeting friends and seeing that everyone was having the best time possible.

At a meeting of the officers and directors 10 days before the Outing, Morris L. Hawkins, Stockham Valves & Fittings, appointed the following members to serve on the Educational Committee; Ray Farabee, Central Foundry Co., Holt, chairman; C. P. Caldwell, Caldwell Foundry & Machine Co.; T. H. Benners, T. H. Benners & Co.; L. N. Shannon, Stockham Valves & Fittings. Mr. Shannon, a former National President of A.F.S., will also serve as Industrial Advisor to the A.F.S. Student Chapter at the University of Alabama.

Twin City

J. D. Johnson
Archer-Daniels-Midland Co.
Chapter Reporter

TWIN CITY Chapter's 1950-51 season opened with a dinner meeting at the Covered Wagon, Minneapolis, September 12. George Anselman, Beloit Foundry Co., Beloit, Wis., spoke on *"Casting Defects."*

The foundryman's fight against scrap is the result of plain carelessness more than of technical inabilities on the part of the foundryman, Mr. Anselman stated, adding that a good basic concept of gating and risering, sand and metal operation, plus good common sense can further scrap reduction tremendously.

Mr. Anselman showed slides of all common types of casting defects and explained their causes and remedies.

Missouri School of Mines

Norbert F. Neumann
Chapter Reporter

New foundry program will be the main objective of the student chapter for 1950-51. Many improvements are planned for the school foundry.

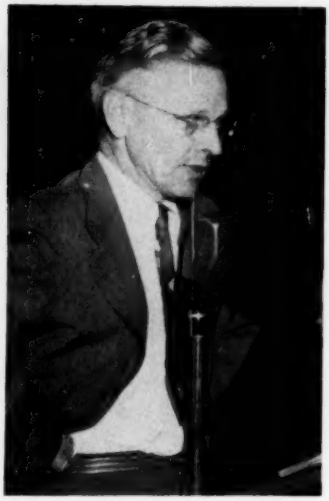
Scheduled for the beginning of the season is a meeting on September 28 with A. L. Hunt, National Bearing Div., American Brake Shoe Co., St.

Looking stuffed and satisfied after a delicious chicken dinner is this group of foundrymen attending Chicago Chapter's Annual Outing, August 12.

Casting weight guessing contest was a feature of Chicago Chapter's Annual Outing, held at Lincolnshire Country Club, Crete, Ill., August 12.

Louis, as speaker, and "Parents' Day" on October 7, when parents and other guests are invited to watch the school's foundry in operation. Feature of this visit will be tapping of a gray iron heat from the cupola.

Officers of the Missouri School of Mines Student Chapter of A.F.S. for 1950-51 are: chairman, George W. Sullivan; vice-chairman, James Templeton; secretary-treasurer, Joseph March; reporter, Norbert F. Neumann; membership chairman, Wade Wurtz; and program chairman, William Ruprecht.



A.F.S. National Director Thomas E. Eagan, Cooper-Bessemer Corp., Grove City, Pa., speaking at the September 8 meeting of the Southern California Chapter. (Photo: K. F. Sheckler, Calmo Engineering.)

Southern California

S. L. Jackson
Electro Metallurgical Div., Union Carbide & Carbon Corp.
Chapter Reporter

FIRST MEETING of the 1950-51 season, held at the Rodger Young Auditorium, Los Angeles, featured a talk by A.F.S. National Director Thomas E. Eagan, Cooper-Bessemer Corp., Grove City, Pa., on *"Practical Application of Ductile Iron."*

Mr. Eagan spoke enthusiastically of this relatively new iron and emphasized the importance of proving its qualifications to engineers and designers. Successful applications of ductile iron in Cooper-Bessemer products have required new methods for testing structural durability of this material, the speaker said.

Mr. Eagan pointed out that it has been necessary to compare the prop-

FUTURE CHAPTER MEETINGS

● **OCTOBER 13-14**
WASHINGTON
BRITISH COLUMBIA
OREGON
OREGON STATE COLLEGE
Gowman Hotel, Seattle
NORTHWEST REGIONAL FOUNDRY CONFERENCE

● **OCTOBER 16**
QUAD CITY
Ft. Armstrong Hotel, Rock Island, Ill.
WILLIAM A. HAMBLEY
Wilson Foundry & Machine Co.
"Casting Defects"

● **OCTOBER 17**
EASTERN NEW YORK
Circle Inn, Lathams
HARRY W. DIETERT
Harry W. Dietert Co.
"Sand Control"

● **OCTOBER 19**
TWIN CITY
Covered Wagon, Minneapolis
F. G. SEFING
International Nickel Co.
"Structure Control Vs. Wear Resistance of Cast Irons"
JOINT MEETING WITH ASM CHAPTER

DETROIT
Student Union, University of Michigan
JOHN GRENNAN
University of Michigan
"Melting in the Cupola"
FATHER AND SON NIGHT. TOUR OF UNIVERSITY FOUNDRY AND PHYSICS LABORATORIES.

● **OCTOBER 20**
BIRMINGHAM DISTRICT
Hotel Tutwiler, Birmingham, Ala.
N. J. DUNBECK
Eastern Clay Products, Inc.
"Cupola Lining"

● **OCTOBER 23**
NORTHWESTERN PENNSYLVANIA
Moose Club, Erie
WILLIAM MOORE
Meehanite Metals Corp.
"Sands and Their Properties"

● **OCTOBER 27**
CHESAPEAKE
Engineers Club, Baltimore
CASTING DEFECTS CLINIC

TENNESSEE
Hotel Patten, Chattanooga
EARL E. WOODLIEF
Sand Consultant
"Foundry Sand and Sand Control"

● **OCTOBER 29**
ONTARIO
Royal York Hotel, Toronto
ALEX PIRRIE
Gurney Foundry Co.
"Patternmaking and Design"

● **NOVEMBER 2-3**
MICHIANA
CENTRAL INDIANA
Purdue University, Lafayette, Ind.
METALS CASTING CONFERENCE

Members of the Chicago Chapter's Entertainment Committee lend a hand with golf tournament registration during Chicago Chapter's Annual Outing, held at the Lincolnshire Country Club, Crete, Ill., on August 12.

FUTURE CHAPTER MEETINGS

● *NOVEMBER 3*

WESTERN NEW YORK
Sheraton Hotel, Buffalo
DONALD HAYES
Laverick & Haines
"Safety and Hygiene"

● *NOVEMBER 4*

TOLEDO
Toledo Yacht Club
Film: *"Fluid Flow in Transparent Molds—Part II"*

● *NOVEMBER 6*

METROPOLITAN
Essex House, Newark, N. J.
PANEL DISCUSSION—*"Foundry Clinic"*

CHICAGO
Chicago Bar Association
ROUND TABLE DISCUSSIONS

WESTERN MICHIGAN
Cottage Inn, Muskegon
KENNETH W. HAAGENSON
Allis-Chalmers Mfg. Co.
"What Kind of Salesman Are You?"

● *NOVEMBER 10*

EASTERN CANADA
Sherbrooke, Que.
PROBLEM CASTING FORUM

SOUTHERN CALIFORNIA
Rodger Young Auditorium, Los Angeles
T. E. BARLOW
Eastern Clay Products, Inc.
"Foundry Sand"

NOVEMBER 10 (CONT'D)

PHILADELPHIA
Engineers Club, Philadelphia
EARL E. WOODLIFF
Foundry Sand Engineer
"Sand Control"

● *NOVEMBER 10-11*

DETROIT
CENTRAL MICHIGAN
SAGINAW VALLEY
WESTERN MICHIGAN
MICHIGAN STATE COLLEGE
MICHIGAN REGIONAL FOUNDRY CONFERENCE

● *NOVEMBER 13*

CENTRAL OHIO
Shawnee Hotel, Springfield
ROUND TABLE DISCUSSIONS

CINCINNATI DISTRICT
Engineering Society, Cincinnati
ROBERT P. SCHAUSS
Illinois Clay Products Co.
"Sand Properties and Casting Defects"

● *NOVEMBER 14*

TWIN CITY
Covered Wagon, Minneapolis
HARRY W. DIETERT
Harry W. Dietert Co.
"Molding Sand for Medium Castings, Natural and Synthetic"

N. ILLINOIS - S. WISCONSIN
Beloit, Wis.
W. T. BEAN, JR.
Industrial Electronics, Inc.
"Good Castings Design—On Purpose!"

Speaker's table at Southern California Chapter's September 8 meeting. Left to right: Philip W. Mettling, S. L. Jackson, Chapter Vice-President Henry W. Howell; A.F.S. National Director Thomas E. Eagan, speaker of the evening; Chapter President John E. Wilson; Chapter Treasurer A. L. Goodreau, Chapter Secretary Harold G. Pagenkoop and Lloyd L. Jones (Photograph courtesy of Kenneth L. Sheckler of Calmo Engineering Co.)

erties of ductile iron with those of gray iron, alloyed iron, cast steel and forged steel for use in equipment, parts, etc.

Service performance has so far proven that laboratory tests are practical. Of particular interest among slides shown were those comparing impact resistance by a modified Izod test, notched fatigue limits, and grain growth at equipment operating temperatures of these materials.

Mr. Eagan said that good technique and control of melting are demanded for production of ductile iron. When melted under proper conditions, the molten iron has good flowability, although slag formed is difficult to remove from the metal. Efficient use of skim gages is required and use of a teapot ladle is recommended, the speaker said.

Prior to Mr. Eagan's talk, Chapter President John Wilson, Climax Molybdenum Co., introduced the members of his staff and committees. Henry W. Howell of Howell Foundry Co., chapter vice-president, introduced the speaker of the evening.

Chapter Chairman C. V. Nass, Pettibone Mulliken Corp., Chicago, greets members and guests at the Chicago Chapter's Annual Outing, held at the Lincolnshire Country Club, Crete, Ill., on August 12.

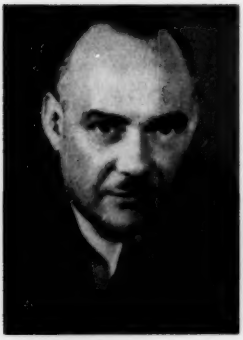
Chicago

I. H. Dennen
Beardsley & Piper Co.
Chapter Reporter

AUGUST 12 was a big day for foundrymen of the Chicago Chapter and their

(Continued on Page 80)

Chapter Officers AFS and Directors



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Toledo, Ohio
Director
Toledo Chapter

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American Wheelabrator & Equip.
Mishawaka, Ind.
Vice-Chairman
Michiana Chapter

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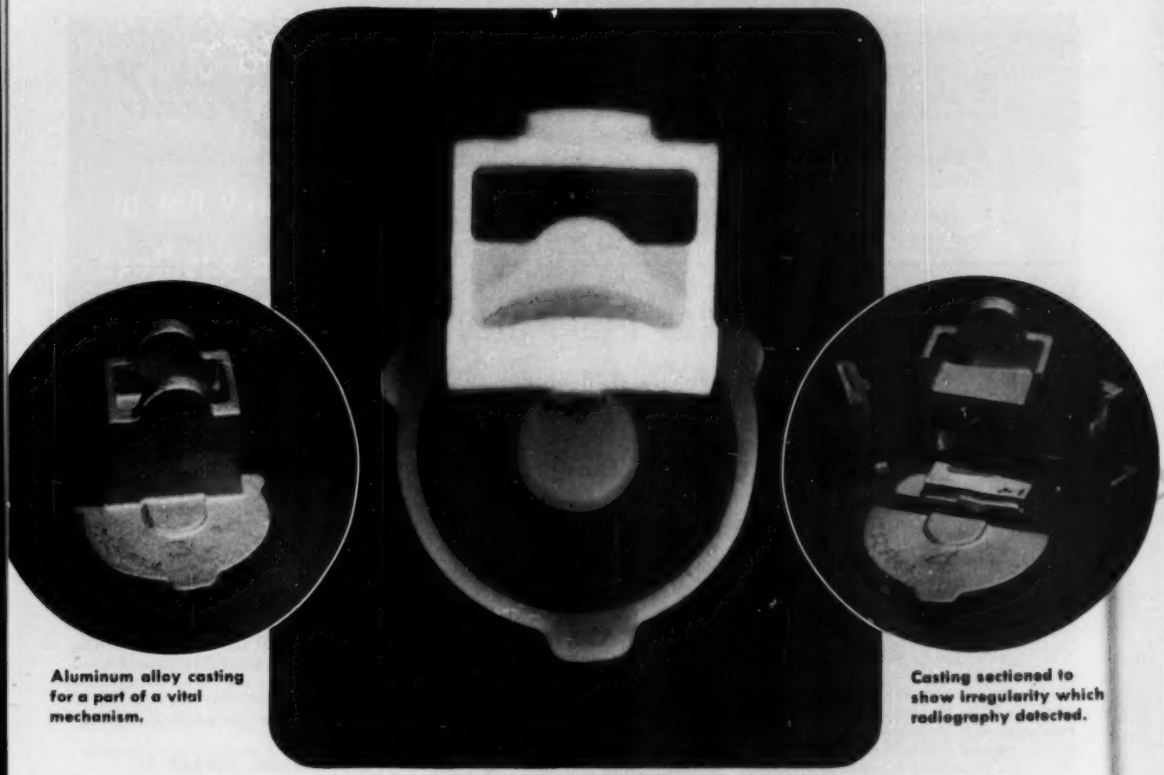
Rochester Chapter



Aluminum alloy casting for a part of a vital mechanism.

Radiograph which revealed imperfection in the casting.

Casting sectioned to show irregularity which radiography detected.

Radiography helps prevent delays in production

ALONG with scores of other castings, this one becomes part of an intricate mechanism. Extremely high quality is a must. Machining is long, complicated, and precise. Should the casting be imperfect, not only the piece and the machining time are lost—the flow of finished parts is disrupted and a whole assembly line delayed.

This is why it pays the foundry well to check the casting radiographically. It is the one way any foundry can be certain it releases only sound castings. And, equally important, it is a way that not only detects irregularities but, at the same time, indicates ways to revise gating, venting, pouring temperature, and other variables which influence consistently good work.

Ask your X-ray dealer to explain the many ways radiography can increase your yield and cut your costs.

EASTMAN KODAK COMPANY
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Radiography...
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ELECTROMET Data Sheet

A Digest of the Production, Properties, and Uses of Steels and Other Metals

Published by Electro Metallurgical Division, Union Carbide and Carbon Corporation, 30 East 42nd Street, New York 17, N. Y. • In Canada: Electro Metallurgical Company of Canada, Limited, Welland, Ontario

How NITROGEN Refines Grain Size...

Produces Harder, Stronger, Tougher Chromium Steels

When nitrogen is added to high-chromium steel, it greatly refines the grain size of the metal and materially increases its strength, toughness, hardness, and wear resistance—without sacrificing ductility or reducing corrosion resistance. For these reasons, nitrogen-bearing chromium steels are well suited for cutlery, turbine blades, and various machinery parts that are subject to extreme wear.

Added to Steel In Ferrochrome

Nitrogen is usually added to chromium steels in the form of nitrogen-bearing ferrochrome containing 0.75 per cent and up of nitrogen, 70 per cent chromium, and a maximum of 0.10 per cent carbon. Depending upon the chromium content of the steel, which can range between 12 and 30 per cent, the nitrogen content may vary between 0.06 and 0.20 per cent. The amount of nitrogen added to high-chromium steels should be 1 part of nitrogen to between 100 and 200 parts of chromium, depending upon the chromium content of the steel.

Nitrogen-bearing ferrochrome is added to the furnace in the same manner as ordinary ferrochrome. Nitrogen recovery will average about 90 per cent.

Improves Cutlery Steel

Cutlery steels and other martensitic stainless steels, such as the 12 to 14 per cent chromium low-carbon steels that are used for turbine blades, are hardenable by heat-treatment. Hardenability and strength increase with the carbon content. And, since nitrogen is a more powerful austenite-former than carbon, it is sometimes used as a substitute for part of the carbon, or as a supplement to the carbon, to increase the strength and hardenability of these steels.

Nitrogen has distinct advantages over carbon for this purpose because ductility, toughness, and corrosion resistance are retained when nitrogen is added to steel. It increases the hardness of cutlery steels without detrimentally affecting toughness or corrosion resistance. The effect of small additions of nitrogen in increasing the hardness of cutlery steels is shown in the table below.

Reduces Grain Growth During Hot-Working

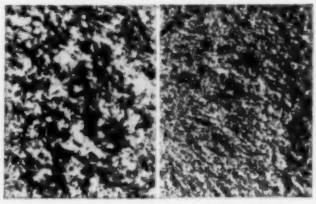
The ferritic high-chromium stainless steels to which nitrogen is added have a finer grain size than ferritic steels without nitrogen, which are comparatively coarse-grained. These include the 16 to 18 per cent chromium wrought steels, high-chromium steels containing small percentages of nickel, and both the cast and wrought 20 to 30 per cent chromium steels. The function of nitrogen when added to the ferritic high-chromium steels is to preserve a fine grain size.

The nitrogen-bearing, high-chromium wrought steels are more readily rolled and forged than comparable steels containing no nitrogen, because grain growth is inhibited during hot-working operations. Greater yields are therefore obtained in rolling and fabricating. Also, strength and toughness are increased as a result of the grain refinement caused by the nitrogen addition.

Effect of Nitrogen on the Hardness of Cutlery Steels*

% Cr	% C	% Si	% Mn	% Mo	% N	Rockwell C Hardness	Brinell Hardness Number (by conversion)
13.15	0.12	0.30	0.38	...	0.03	41	387
13.25	0.13	0.29	0.42	...	0.10	48	460
13.36	0.23	0.28	0.40	...	0 03	46	437
13.27	0.21	0.34	0.32	...	0.08	51	496
12.70	0.32	0.30	0.37	...	0.04	50	484
13.41	0.35	0.31	0.41	...	0.11	56	560
17.37	0.41	0.32	0.41	0.75	0.036	41	382
17.25	0.44	0.30	0.42	0.75	0.09	53	522
17.30	0.66	0.29	0.38	...	0.03	51	496
17.08	0.60	0.31	0.40	...	0.11	55	547
17.26	0.80	0.28	0.39	0.76	0.032	52	509
17.25	0.80	0.27	0.45	0.74	0.09	57	573

*Steels oil-quenched from 950°C. Held 5 hr. at 200°C. and air-cooled.



Note the extent to which nitrogen refines the grain size of those specimens containing about 27 per cent chromium and 0.35 per cent carbon. The specimen at the left contains 0.05 per cent nitrogen; the one at the right, 0.30 per cent nitrogen.

Greater Strength for Austenitic Steels

Small percentages of nitrogen will increase the yield point and tensile strength of the austenitic chromium-nickel steels. These include the well-known 18 per cent chromium, 8 per cent nickel steels, and also the 25 per cent chromium, 12 per cent nickel steels. The improvement in strength is gained at no sacrifice of workability. Furthermore, nitrogen promotes the formation of austenite.

Metallurgical Service Available

ELECTROMET nitrogen-bearing ferrochrome is furnished in the following standard analysis:

Chromium	67 to 71%
Carbon	0.10% max.
Silicon	0.30 to 1.00%
Nitrogen	0.75% approx., or higher if desired.

It is available for immediate shipment in lump sizes of 25 lb. by 8 mesh, or 15 lb. by 8 mesh; also, in a crushed size of 2 in. by down.

If you would like additional information about the production of nitrogen-bearing steels, ask to have one of our metallurgists call, or ask for the booklet, "Nitrogen In Chromium Alloy Steels." Write to the address given above or to the ELECTROMET office nearest to you. Offices are in Birmingham, Chicago, Cleveland, Detroit, Los Angeles, New York and San Francisco. In Canada: Welland, Ontario.

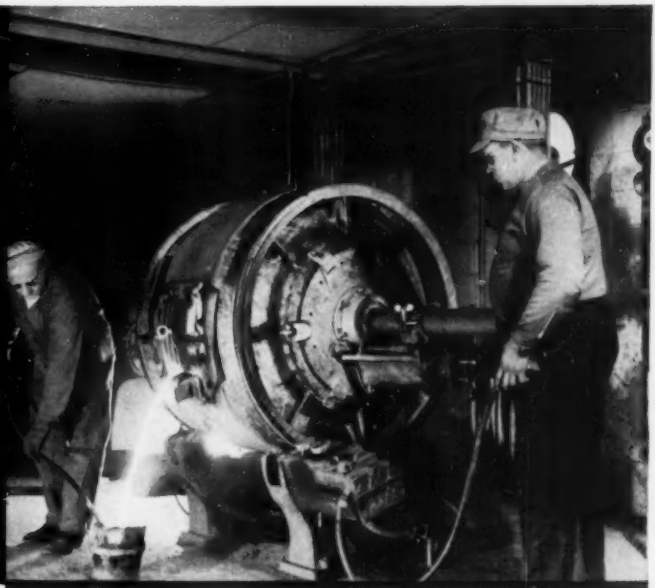
The term "Electromet" is a registered trademark of Union Carbide and Carbon Corporation.

No pigs

in 168,930 lbs. of synthetic alloy iron

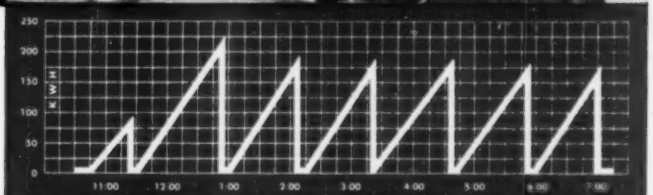
●

A DETROIT ROCKING ELECTRIC FURNACE Melts Scrap with Economy and High Uniformity



No pigs were used in the production of 168,930 lbs. of uniform quality synthetic alloy iron by the Detroit Rocking Electric Furnace shown above. All charges were of scrap and graphite only.

Big savings were made on raw materials. Melt quality and homogeneity were rigidly maintained by automatic control.



One month's operation of type LFY, 175 KW, 700 lb. nominal cold charge capacity Detroit Rocking Electric Furnace. High strength, alloy automotive irons poured at 2800-3000° F.

● No. heats per day—7 ● Av. heat weight—1000 lbs. ● Total lbs. cold melted—168,930 ● Av. power consumption, including preheat—549 KWH/ton ● Total average cost for power, refractories, and electrodes, $11.41/ton.

NOTE: Operator handles two such furnaces all day. Furnaces are equipped with automatic electrode control as well as automatic rocking control.

Get Multiple Savings

In your melting operations, you'll achieve better castings, fewer rejects, higher usable yields with Detroit Rocking Electric Furnaces. Faster melts mean more heats per day.

Because the electrodes are always clear of the molten bath, carbon pick-up is eliminated. Indirect arc and automatic electrode adjustment result in optimum power use. All-electric operation excludes costs of handling and storing bulky fuels. Control of interior atmospheres assures peak quality.

Linings last longer. Replacement linings are installed quickly, with least out-of-production time.

Increase YOUR Profits!

Whether you melt ferrous or non-ferrous metals, Detroit Rocking Electric Furnaces will give you top melting economies. Send us your production data. Our engineers will furnish facts on how you benefit through better quality control, greater production, with Detroit Rocking Electric Furnaces. Available with conical or cylindrical chambers, in capacities from 10 to 4000 lbs. Write, now, to:

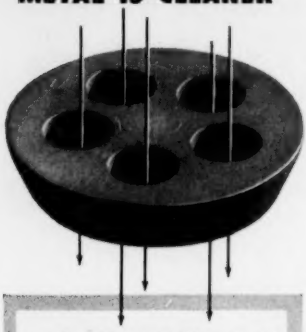
FEMA

DETROIT ELECTRIC FURNACE DIVISION

KUHLMAN ELECTRIC COMPANY • BAY CITY, MICHIGAN

Foreign Representatives: In BRAZIL—Equipamentos Industrias "Eisa" Ltd., Sao Paulo; CHILE, ARGENTINA, PERU and VENEZUELA: M. Castellvi Inc., 150 Broadway, New York 7, N. Y.; MEXICO: Casco, S. de R. L. Atenas 32, Despacho 14, Mexico City, D. F.

CERAMIC STRAINED METAL IS CLEANER



ALSIMAG® Ceramic STRAINER CORES MEAN CLEANER CASTINGS —FEWER REJECTS

Don't be satisfied with your foundry operation until you have tried ALSiMag Strainer Cores. They strain the incoming metal and regulate its flow—thus greatly reducing the possibility of sand in the casting. Check these features:

1. Little abrasion from metal stream
2. Allow positive even flow of metal
3. Even thermal expansion
4. Withstand all normal pouring temperatures
5. Tough, easy to use on fast production

ALSIMAG CUT-OFF CORES
Used in neck of riser to form weak joint between riser and casting. Riser can be knocked off in one easy operation. Eliminates cut-off time.

ALSIMAG GATE TUBES
Keep gate sand from getting into casting. These tubes form a smooth ceramic liner for metal to pass through. Give cleaner castings.

TEST THESE PRODUCTS IN YOUR OWN FOUNDRY: Samples of products mentioned above and other ALSiMag ceramics are available in stock sizes free on request. Samples to your own specifications will be made at minimum cost. Write today.

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CHAPTER ACTIVITIES

(Continued from Page 73)

friends when the Chapter held its annual outing at Lincolnshire Country Club, Crete, Ill. Outing Chairman Robert Jones and his committee arranged a wonderful day for over 900 foundrymen. A golf tournament on Lincolnshire's beautiful course was a feature of the day. For non-golfers a full afternoon of entertainment was provided on the grounds. Horseshoe pitching attracted many participants and spectators alike, and a musical trio provided the background for all activities. Before the afternoon ended, each foundryman had an opportunity to guess the weight of a group of castings. Guesses varied from 200 to 1000 lb. The winner was Doyle Sweet whose guess was within 1 lb of the correct weight—532.14 lb.

A chicken dinner was followed by a full evening of entertainment. All in all it was a memorable day for everyone.

The program committee of the Chicago Chapter met on September 11 at the Union League Club to plan meetings for the coming year. Representatives of each segment of the industry joined with Walter W. Moore of the Burnside Steel Foundry, chapter vice-chairman and program committee chairman, to determine the technical program and speakers for 1950-51 Chicago chapter meetings.

Chicago Chapter meetings are held on the first Monday of each meeting month at the Chicago Bar Association 29 S. LaSalle Street. If the attendance for the remaining seven meetings approaches that of the first meeting, held on October 2, this will be a highly successful season, it is predicted.

Over 200 foundrymen attended and heard a panel of experts discuss the clean air problem in foundries. Included in the panel were Frank Chambers, Chicago municipal expert; Vernon G. Leach, Peabody Coal Co., chairman of the Chicago Cleaner Air Committee, and James R. Allen, chairman of the Foundry Industry Sub-committee of the Chicago Clean Air Campaign. Mr. Allen, affiliated with International Harvester Co., was the principal speaker and discussed at length the current dust abatement problems existent in the foundry industry.

Next meeting, to be held on November 6, will feature round table discussions on gray iron, steel, malleable and non-ferrous foundries and pattern shops. Among the subjects to be discussed are *"Co-operation Between the Jobbing Foundry and the Pattern Shop," "Casting and Pattern Design for Armor Plate," "A Clinic on Malleable Headaches,"* and *"Questions and Answers on Brass and Bronze."*

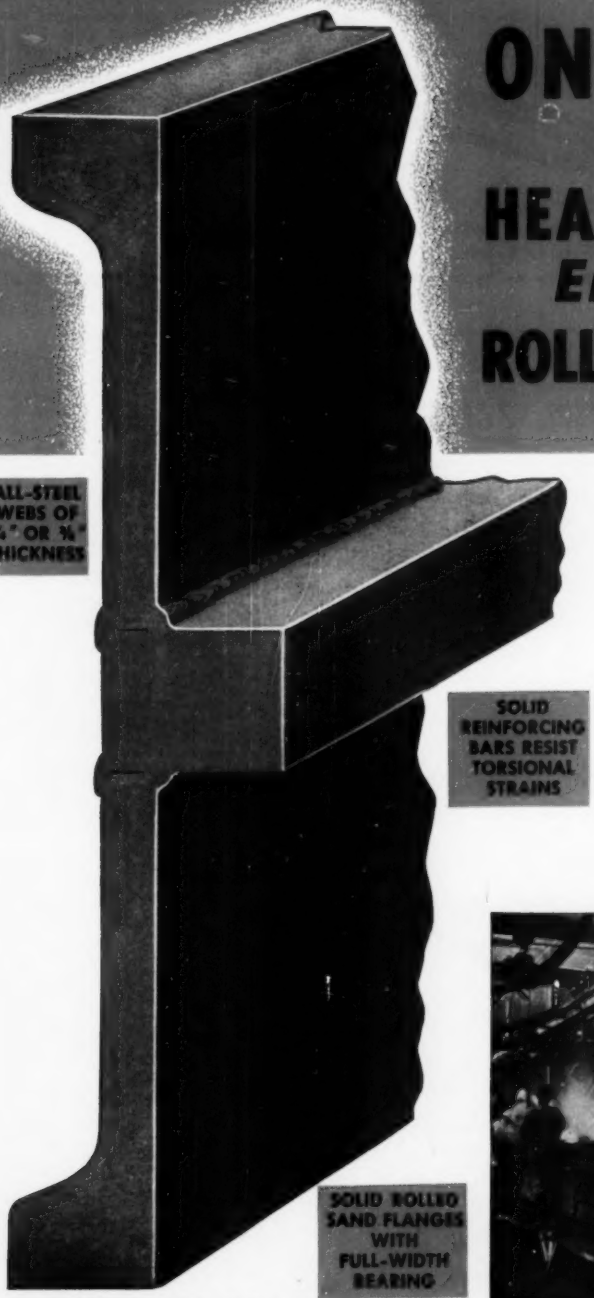
Saginaw Valley

NEWLY-ELECTED officers and directors of the chapter, advanced to fill the position of chapter chairman, recently vacated by Howard H. Wilder, who has accepted a position with Vanadium Corp. of America, Detroit, are: *chairman*, Raymond H. Klawuhn, General Foundry & Mfg. Co., Flint (formerly vice-chairman); and *vice-chairman*, A. E. Edwards, Chevrolet Grey Iron Foundry, Flint (formerly a director). E. L. Waterhouse, Foundry Div., Eaton Mfg. Co., Vassar, Mich., has been named to succeed Mr. Edwards as a director of the Saginaw Valley Chapter. His term of office expires in 1951.

1950-51 officers of the A.F.S. Missouri School of Mines Student Chapter photographed with MSM faculty members are, left to right: Membership Chairman Wade Wurtz, Program Chairman William Ruprecht, Professor Daniel F. Eppelsheimer, faculty sponsor of the Student Chapter; Vice-Chairman James Templeton, Dean Curtis L. Wilson, Secretary-Treasurer Joseph March, Chairman G. W. Sullivan and Reporter Norbert Neumann.

MORE THAN 4500 FOUNDRIES ARE USING STERLING FLASKS

ONLY STERLING *Gives You* HEAVY-DUTY FLASKS *Engineered from* ROLLED CHANNEL STEEL

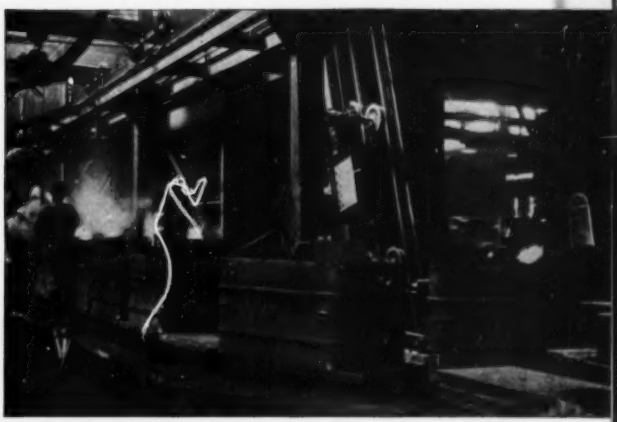

ALL-STEEL WEBS OF ¼" OR ⅜" THICKNESS
SOLID REINFORCING BARS RESIST TORSIONAL STRAINS
SOLID ROLLED SAND FLANGES WITH FULL-WIDTH BEARING

UP AND DOWN THRUST — Sections retain the same height. Will not collapse after continual usage. Heavy sand flanges with full-width bearing. Cannot curl under jolt action.

Almost a Half Century of "Know-How" Assures Precision-Built Steel Flasks Fabricated to Highest Quality Standards

You can always rely on Sterling Heavy Duty Flasks because they are carefully fabricated from hot rolled steel of 70,000 lbs. tensile strength and copper bearing. Backed by almost a half century of experience in this specialized field. All-steel welded construction . . . solid reinforcing bars . . . heavy rolled steel flanges . . . square corners . . . full-width bearing. These are Sterling patented, life-prolonging features that assure rigidity and accuracy, even under constant production pressure. Sterling Flasks are available in a variety of styles and shapes to meet your needs. Write for Catalog No. 60A.

STERLING WHEELBARROW CO.
Milwaukee 14, Wisconsin, U. S. A.



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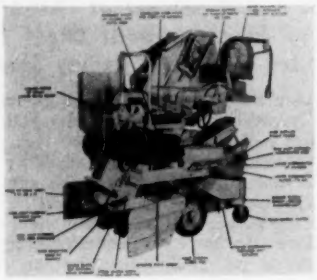
NEW Foundry Products

Readers interested in obtaining additional information on items described in New Foundry Products should send requests to Reader Service, American Foundryman, 616 S. Michigan, Chicago 5, Ill. Refer to the items by means of the convenient code numbers.

Sand Conditioner

1—Redesigned to incorporate 20 improvements which provide greater capacity and smoother, more efficient operation, the Nite-Gang is a self-propelled sand preparation unit requiring only one operator. After castings are removed



from shakeout sand, Nite-Gang moves in and its rotating spiral blends sand and additions. Mixture is conveyed to bucket elevator, where it is further blended and discharged over magnetic separator. Iron-free sand falls into high-capacity screening unit, where it is thoroughly screened, aerated and discharged into pile, bin or windrow. Swivel mounted screening unit has adjustable spout that permits discharge to any distance within 50 ft and in any direction within an arc of 240 degrees. *Beardsley & Piper Div., Pettibone Mulliken Corp.*

Sectional Matchplate Frames

2—Interchangeable sectional matchplate frames of cast aluminum enable foundrymen to convert readily from loose pattern to matchplate molding using plastic or other composition patterns. Sections of the frame are grooved to receive matchplate sections and may be assembled in combinations for a single plate or for several small plates to permit composite molding. Brass processing frames adjustable to quarter, half, and full-sized sections are available for casting plastic patterns to be inserted in the aluminum frames used on the molding floor. Patterns are easily interchanged with less than one minute being required to make insertions, removals, or substitutions. Advantages claimed by manufacturer include decreased plate cost, decreased molding cost, and increased production. (See strip at bottom of page.) *Efficiency Match Plate Co.*

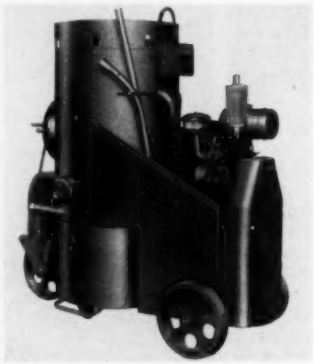
Portable Grinder

3—Newly-designed, heavy duty, 6-in. portable grinder is engineered for continuous operation and is applicable to the grinding of heavy castings, and wire brushing, buffing and polishing of any metal surface. Grinder will also cut off pins, bolts, studs and rivets and remove heavy rust, scale and paint. Features of this 19½-lb tool are molded, covered rear handle for comfort and positive control, and eye bolt for providing overhead

suspension. Model 142 grinder has Universal motor, d-c or a-c up to 60 cycles, with no-load speed of 3800 rpm. Die cast aluminum housing, sealed ball bearings and fully-enclosed commutator and switch. Length: 23½ in. *Skilsaw, Inc.*

Portable Vacuum Cleaner

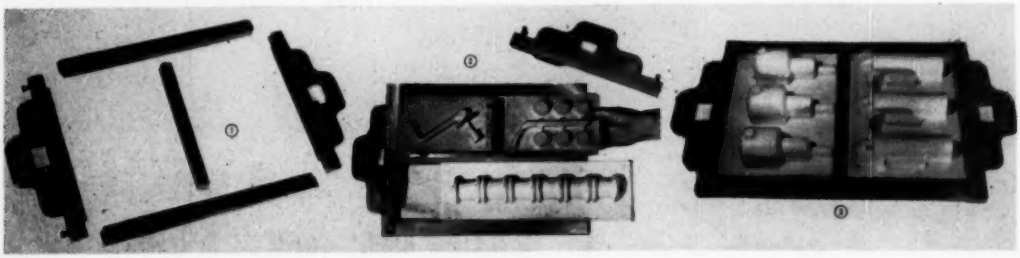
4—Gasoline-engine powered portable vacuum cleaner is designed to provide industrial vacuum cleaning for applications where cost of electric wiring is excessive, or for large plants where cleaning is required in widely scattered loca-



tions. Hoffco-Vac # 50 cleaner is powered by 4-cycle, single cylinder, air-cooled engine rated at 6.8 hp and equipped with flame arrester muffler. V-belt drive connects with multistage centrifugal exhauster. Two sweeper cleaning is provided with 7½ cu ft dust container capacity and simultaneous operation of two 50 ft lines of 1½ in. hose. For single sweeper use, one 75 or 100-ft length of 2 in. hose can be operated. *Air Appliance Div., U. S. Hoffman Machinery Corp.*

Aluminum Painting Process

5—Pylumin Process, designed for the protection of aluminum products, pro-



vides an adhesive base for paint finishes or acts as a corrosion-resistant coating if no paint finish is applied. This immersion process employs a single premixed powder, eliminating chance of error in proportioning. Ordinary heated steel tanks are all the equipment required and, unless there is an exceptional amount of grease and dirt on parts to be processed, no special cleaning is required in advance. Adaptable to either large or small scale operation, process can be used on widely varying products made of aluminum and aluminum alloy. There are no dimensional changes and it is not necessary to allow for close tolerances. Furnished with test kit. *Pyrene Mfg. Co.*

Super Refractory

6—Allmul, a super refractory for lining high-temperature furnaces, will not melt until heated to more than 3300 F, and when heated to 3000 F will support 1000 lb without deforming. When successively heated to 2550 F and sprayed with cold water a dozen times, Allmul has shown no signs of cracking or chipping. Mass produced, this refractory meets all specifications and sells at approximately one-half the usual price of similar refractories, manufacturer claims. Available in firebrick, grain and ramming mix forms. *Babcock & Wilcox Co.*

Riser Compound

7—Thermit Riser Compound is designed to assure sound castings by promoting proper directional solidification, reducing special casting design by eliminating many chills and blind risers, and reducing required volume of riser metal. Mixtures are available for cast iron, mild steel and various stainless steels. *Metal and Thermit Corp.*

Pre-Paint Cleaner

8—Compound 33 performs three important pre-paint metal cleaning functions—(1) removes oil, (2) removes dust and (3) prepares metal for paint—all in a single procedure. Compound 33 has solvent and detergent properties effective in removing oils, rust preventatives, carbon smuts, soldering and welding fluxes, identification inks and similar soils. Compound's acid ingredients act on rust, heat scale, tarnish and other oxides. Accelerating agents enable Compound 33 to remove rust and oil quickly. Compound 33 converts surface layer of metal into thin film of insoluble phosphates, providing excellent bond for paint. *Oakite Products, Inc.*

Castings Reclamation Process

9—High-pressure unit, designed for use with the Tincher Process for reclaiming defective castings, treats all internal and external surfaces simultaneously. Before or after machining, castings are placed in wire basket, which is lowered into tank. Cover is secured and special sealing agent is forced into tank under high-pressure, sealing all pores and voids in the castings. After treatment, no washing or curing is needed and no evidence of impregnation remains. Unit is designed to treat small valve and pump housings, hydraulic brake cylinders, fittings and similar cast parts. *Tincher Products Co.*

Automatic Air Oiler

10—B.R. automatic air oiler, an engineering development of a French foundry supply firm, can be installed on any foundry air pulsation equipment to save maintenance costs and give positive lubrication distribution. Measuring 8 in. x 3½ in., with reservoir capacity of ¾ pint, oiler is cut into airline on any air pulsation equipment. Part of air in main supply line is by-passed through lubricator, then bubbled through oil in reservoir. As bubbles break, they are atomized. Atomized oil and air mixture is then returned to main line. Available for easy installation on any type of foundry equipment from the *Davenport Machine & Foundry Co.*

Roof Ventilator

11—Motor-driven vertical discharge roof ventilators are designed for exhausting air from foundries, machine shops and buildings where harmful exhaust fumes must be discharged into air as far as possible above the roof. Ventilators are available with fan wheels 36, 42 and 48 in. in diameter and in capacitites up to 40,900 cfm. Units are weatherproof at all times. *DeBothezat Fans Div., American Machine & Metals, Inc.*

Fluorescent Defect Detector

12—Fluoretor, a portable, self-contained fluorescent unit for non-destructive testing of castings weighs only 2 lb and operates from a pair of standard D flashlight batteries. This portable dark room can be used to examine specimens anywhere without being affected by outside light. Unit has magnifying, focussing eyepiece which aids scrutiny of defects and at the same time protects user's eye from harmful effects of ultraviolet rays. Instantly started, unit costs about 1¢ per hr to operate in normal use. *Menlo Research Laboratory.*

Bench Grinder

13—Vertical spindle grinder, designed for free-hand grinding of castings where little stock removal is required, is claimed by manufacturer to increase production and promote safer operation because all grinding is done on horizontal plane. Model 318-18" has 18 in. abrasive wheel, weighs 575 lb, is 31 in. high and 28½ in. wide, and can easily be installed on bench of suitable height if bench mounting facilities are lacking. Ruggedly constructed, unit has 3-phase, 60-cycle axial air gap motor developing 5 hp at 1160 rpm. Crossarm, pedestal, motor-driven coolant pump, tank and pumping for wet grinding are optional. *Charles H. Besley & Co.*

(Continued on Page 88)

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FOUNDRY Literature

Readers interested in obtaining additional information on items described in Foundry Literature mail postcard below to Reader Service, American Foundryman, 616 S. Michigan Ave., Chicago 5. Refer to items by circling the convenient code numbers.

Automatic Control Film

14—16 mm sound and color film, "Principles of Automatic Control," produced by the Instrument Society of America, presents subject of automatic control to operators, technical personnel and students. Running time: 55 min. *Instrument Society of America.*

High Tensile Steel Welding

15—Booklet, "ABC's of Welding High Tensile Steels" shows effectiveness of low hydrogen electrodes in welding low alloy, high tensile steels, mild steel under restrained conditions, and sulphur bearing free machining steels. *Arcos Corp.*

Micro Particle Classifier

16—Data sheet describes No. 6000 Micro Particle Classifier, for centrifugally dividing such fine particle materials as dusts, wood and mineral flours, investment materials, smog particles and many others. Listed are applications, time required for tests, reproducibility, operations and specifications. *Harry W. Dietert Co.*

Blast Protection Equipment

17—4-page bulletin No. CS-26 describes personal protection equipment for shot and sand blasters, including the new MSA Abrasive Mask and MSA Blastfoe Abrasive Helmet. Also described and illustrated are air supply accessories, clean air blower, valves, filters and pressure regulators. *Mine Safety Appliances Co.*

Metal Cleaning

18—44-page illustrated booklet reviews metal cleaning in all phases, including tank cleaning, machine cleaning, electrocleaning of steel, brass and non-ferrous metals, pickling, deoxidizing, bright dipping, prepaint cleaning and surface preparation, steam-detergent cleaning, barrel cleaning and burnishing. Also offered are recommendations for improving effectiveness of metal cleaning operations in hard water areas; for anti-rust protection of parts in production and during storage; on coolants and lubricants for machining and grinding; simplified paint stripping methods; and on treating wash water in paint-spray booths. *Oakite Products, Inc.*

Portable Arc Welders

19—4-page illustrated folder shows and describes 15 features of gasoline-driven arc welders and gives specifications of 10 models of gasoline-engine-driven arc welders and combination models of arc welders and power units. *Hobart Bros. Co.*

Filing System

20—Folder lists advantages of Triple Check Automatic filing system for files of 10 drawers or more. Simple and rapid, system files by letter, controls by number, and checks by color. Installation can be accomplished without disrupting regular office procedure. *Remington Rand Inc.*

Steam Generation

21—Pictorial display panel, available without charge to engineering colleges, technical schools and industrial training courses, outlines development of steam generation from Roman times to the present. Measuring 36 in. high x 54 in. long, panel consists of series of pictures with accompanying text showing high spots in boiler development. *Babcock & Wilcox Co.*

Pressure Boosters

22—12-page illustrated bulletin No. B-200 describes low-cost production line of fluid pressure boosters. Applications, selection of proper sizes and types and descriptions of single and double acting boosters in single and dual pressure cir-

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81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100

cuits are given. Circuit diagrams, simplified formulae for calculating boosters, illustrations and descriptions of models available, mounting and dimensional data and handy booster selector chart are included. *Miller Motor Co.*

Degassing Non-Ferrous Metals

23—4-page catalog section M-8709 describing graphite fluxing tubes for introduction of such gases as nitrogen, chlorine, argon and helium into molten non-ferrous metals to reduce hydrogen, oxygen and inclusions; and reprint of article, "Degassing Non-Ferrous Metals," by E. Kurzinski, are offered by *Linde Air Products Co.*

Recessing Tools

24—Illustrated technical manual DB utilizes photographs, diagrams, sketches and cutaway illustrations to indicate construction features and show operating principles of newly-designed recessing tools. *Maxwell Company.*

Heat Treating Ovens

25—12-page folder describes complete line of heat-treating ovens, comprising three major categories of standard and special design—batch type, pit type and continuous conveyor type. Ovens described in Bulletin 4-T use heat up to 1000 F and are for use in heat treating cast iron, steel and non-ferrous metals. *Young Bros. Co.*

Flexible Mold Materials

26—6-page data sheet describes applications, product preparations and lists prices of liquid synthetic rubbers. Solvent-free, non-shrinking and permanent, the liquid synthetic rubbers described (S-70, cold-poured and cured at 70 F, two component; D-70, cold-poured and cured at 70 F, two component; and V-185, cold-poured and cured at 185 F, one component) are used to make molds in which matchplate patterns are reproduced. No sealant or separator is required on mold surface, and mold flexibility makes for easy extraction of cast patterns. Liquid synthetic rubbers can be used to make investment molds of silica, sand or plaster. Flexibility can be varied to meet most delicate casting requirements. Recommended by manufacturer for Croning Process sand molds. *Ernest F. Boruski, Jr.*

Special Shape Refractories

27—Single-page bulletin describes special shape refractories of flint and semi-flint clays, engineered to meet individual furnace conditions. Production operations are illustrated and special shapes shown. Also described is special method of drying shapes. *Ironton Fire Brick Co.*

Sand Mullers

28—36-page catalog gives complete information on foundry sand mulling and progress of mulling, in addition to complete specifications and applications for six models of Speedmullors. Exclusive Speedmullor feature of cooling hot sand during mulling cycle is explained and illustrated. *Beardsley & Piper Div., Pettibone Mulliken Corporation.*

Aluminum Heat Treatment

29—Data sheets list heat treatment conditions for all heat treatable alloys included in BS. 1490 and contains notes on recommended practice, heat treatment of pressure die-castings and stabilizing of stress relief. Sheets are available without charge from *Alar, Ltd. (British Association of Light Alloy Refiners).*

Air Tools Catalog

30—44-page illustrated catalog contains complete specifications on 147 models of portable air tools and information on accessories. Shown for first time in this catalog are new line of medium duty sanders, three models of belt sanders, plus reamers, screwdrivers, nutrunners, etc. *Buckeye Tools Corp.*

Coal Dust Control

31—4-page illustrated folder describes the Aquadyne "Wet Water" System of coal dust control. Manufacturer claims coal dust hazards can be eliminated for 1¢ per ton, and for 1¢ more per ton, dustless ashes can be produced. *Aquadyne Corp.*

Laboratory Equipment

32—Comprehensive catalog No. 50 lists complete line of chemical and biochemical laboratory apparatus and equipment. Alphabetically arranged, with occasional functional groupings, catalog covers apparatus for research and routine work in industrial, educational and institutional laboratories and achieves useability through elimination of outdated and seldom-used items. *Schaar & Co.*

Concrete Floor Patch

33—8-page illustrated bulletin describes iron asphalt material for patching and resurfacing of concrete floors. Scientifically graded, this ductile, metallic aggregate insures long floor life by overcoming crushing and spreading of repair material and eliminating early break down of feather edges. *Master Builders Co.*

Rammer-Compression Tester

34—Data sheet describes combination rammer, compression tester, designed to ram sand test specimens for permeability and compression tests and to test specimens in compression. Listed are construction, operation and advantages of unit. *Claud S. Gordon Co.*

Disc Grinding

35—An 18-page booklet 5 x 7 in., on disc grinding discusses safe handling, storage mounting and use of abrasive discs and describes features peculiar to this type of precision abrasive grinding. *Grinding Wheel Institute.*

Stainless Steel Castings

36—Castings of stainless steel ranging from 1 oz to 2500 lb are described in an illustrated four-page folder designed to aid buyers who require corrosion resistant castings for their products. Detailed information is given on the properties of stainless castings, the processes that go into their making, as well as on such corollary services offered by the company as pattern shops, machine shops and finishing shops. *Buffalo Stainless Casting Corp.*

Laboratory Combustion Unit

37—New high-frequency Lindberg "H-F" combustion unit for igniting samples in the determination of carbon and sulphur in iron and steel analysis is described in a four-page illustrated folder. Unit generates heat only in metal sample, attaining temperatures up to 3000 F. Folder compares accuracy of carbon determination by conventional methods with that obtained by "H-F" combustion, and also compares the old and new methods of sulphur determination. *Boder Scientific Co.*

Air Traps

38—4-page bulletin describes complete line of air traps for automatic drainage of moisture from compressed air intercoolers, after-coolers, receivers, separators and drip points. Applications and physical data included. *Armstrong Machine Works.*

Refractory Concrete

39—Revised edition of 24-page booklet giving latest information on refractory and heat-resistant concrete contains detailed information on mixes, proportions and various aggregates. Tables aid in selection of proper types of refractory concrete for wide range of temperatures and insulating conditions. *Lumnite Div., Universal Atlas Cement Co.*

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FOUNDRY FIRM *Facts*

Pyro Refractories Co., Oak Hill, Ohio, announces the removal of its Chicago office from 20 North Wacker Drive to 5252 Broadway, Chicago 40.

W. G. Reichert Engineering Co., Newark, N. J., announces the formation of a **Push-Button Foundry Equipment Division.** This Division will manufacture and install completely automatic machines that will carry through all mold making operations, from flask return at the shakeout to finished mold at a single push of a button; a shakeout that operates automatically, with no manual labor involved; and push-button controlled metal pouring equipment. This equipment is already in continuous production. The Reichert organization manufactures and installs these machines and equipment and instructs foundries in their operation.

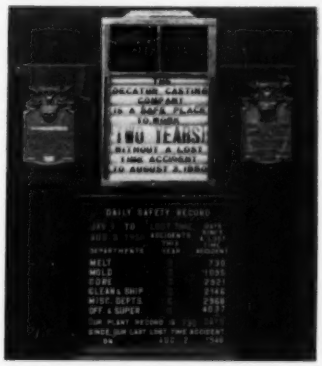
Mackintosh-Hemphill Co.'s Midland, Pa., plant was recently the recipient of a trophy awarded by the Metals Section of the National Safety Council and, for the fourth time, the Steel Founders' Society of America's award for industrial safety. The plant has established a record of no lost time accidents from March 25, 1949, to date.

Alabama By-Products Corp., Birmingham, has authorized construction of an additional battery of 29 coke ovens, capable of producing 150,000 tons annually of coke and essential coal chemicals, at its Tarrant, Ala., plant. The action was taken to insure continuous coke supplies to vital defense industries throughout the country in the present national emergency. It is anticipated that the new ovens will be in operation by July, 1951.

Admiral Die-Casting Co. is constructing a one-story, 21,000 sq ft factory at 310 W. 83rd St., Chicago, for the production of aluminum castings.

Lincoln Smeting & Refining Co., a new organization, has leased a building in Bedford Park, Ill., a Chicago suburb, for resmelting and reclaiming of non-ferrous metals.

Electric Steel Foundry Co.'s Eugene, Ore., branch officially opened its new modern office at 1464 West Sixth St., Eugene, with an open house on July 22. The 5700 sq ft structure houses both office and warehouse facilities. In addition to the ESCO lines of contractors' equipment, logging, rigging and sawmill parts, the branch represents the J. W. Minder Chain & Gear Co., Dodge Mfg. Co., American Chain & Cable Co. U. S. Electrical Motors, Union Roller Chain Co., Moline Malleable Iron Co., Armco Steel Corp., Carpenter Steel Co., Tri-Clover Machine Co., and Ohio Gear Co.

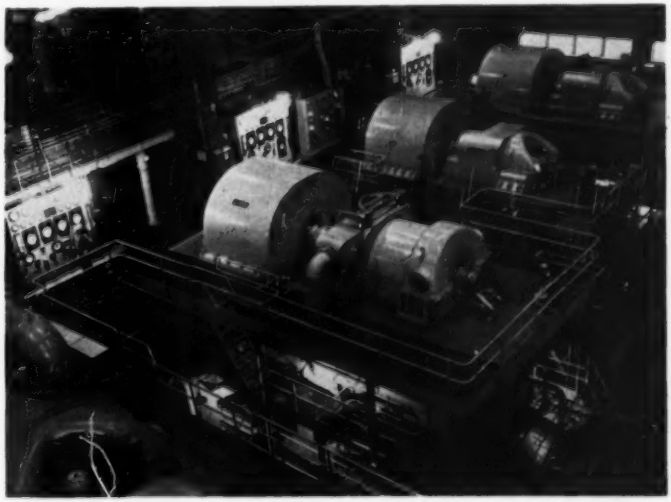


No lost-time accident record of the Decatur Casting Co., Decatur, Ind., now stands at almost 800 days. Safety honors awarded Decatur Casting include four achievement awards from the National Safety Council and three awards from Michigan Mutual Liability Company.

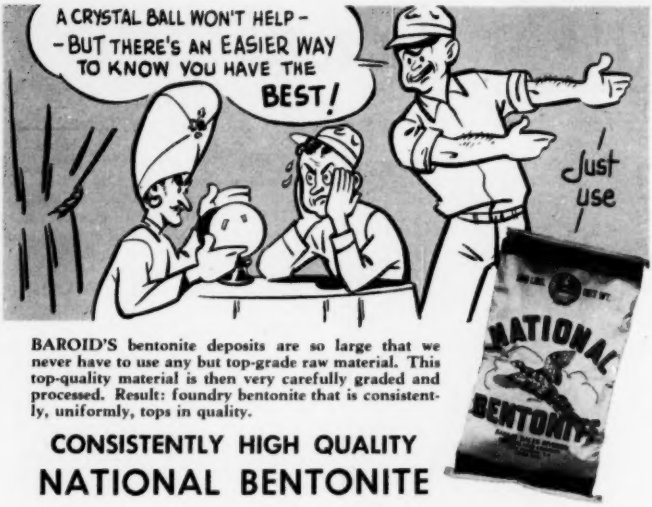
Jones & Laughlin Steel Corp. has authorized construction of a one-story storage building, 90 ft wide x 720 ft long, at its Pittsburgh Works. **Rust Engineering Co.,** Pittsburgh, has contracted to construct the building and install crane runways.

Vulcan Mold & Iron Co., Latrobe, Pa., announces that it will construct a $1 million plant at Lansing, Ill., a suburb of Chicago, for the manufacture of all types of ingot molds and accessories. Designed to produce some 50,000 tons a year, the new mold plant is the first to be built in the Chicago area in 25 years and will serve Midwest, Southwest and Western markets. Construction of the new plant began early in September, with April 1, 1951, set as deadline for its completion. The plant will be known as the Chicago Division of Vulcan Mold and Iron Co.

General Electric Research Laboratory, the nation's first industrial research laboratory, celebrated its 50th anniversary the week of October 9 with formal dedication of its new home near Schenectady, N. Y. A revolutionary type of laboratory structure, the newly-completed plant has been under construction since 1946 and is made up of five buildings with a usable area of about 185,000 sq ft. First started in a barn behind the home of famed scientist Charles P. Steinmetz, the Laboratory has been devoted to fundamental scientific knowledge since its inception. This knowledge has been passed on to American industry in the last half-century in such forms as the tungsten incandescent lamp, the gas-filled incandescent lamp, the Coolidge x-ray tube, the high-power electron tube, silicones, "atom smashers" and betatrons.



Joining two others placed in operation in 1943 at the Edgar Thomson Works of the Carnegie-Illinois Steel Corp. is the large blast furnace turbo blower in the foreground. Installed recently by Dravo Corp., unit has 121,000 blast air cfm capacity, operates at 650-lb steam pressure.



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NATIONAL LEAD COMPANY

BENTONITE SALES OFFICE
RAILWAY EXCHANGE BLDG.
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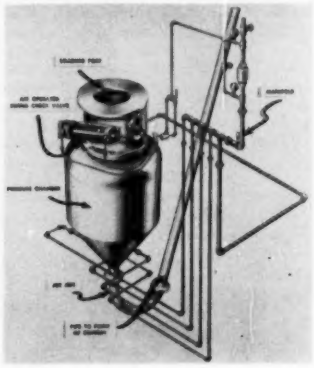
NEW PRODUCTS

(Continued from Page 83)

For detailed information on any New Products listed, circle corresponding postcard coupon number, Pp. 83.

Pipe Line Conveyor

40—Turbo-Drive, a pneumatic conveyor system for bulk materials, operates from air pressure and consists of an entrance or swing check valve through which material is loaded into pressure chamber for



batch moving of sand or other granular, crushed or pulverized materials from receiving to storage and from storage to point of use. Turbo-Drive delivers each batch complete, eliminating contamination between batches of different materials. Material is enclosed in steel pipe, keeping it clean and eliminating raising of dust. A ton or more of material can be moved in a few minutes. One operator controls entire system. Dispatch to more than one location is possible through use of transfer switch. Turbo-Drive conveyor is available in 7, 15 and 30 cu ft capacities. *Crane Co.*

Vibrating Machines

41—Two units incorporating entirely new principles of vibration are the Vibra-Feeder (R), mechanically-operated and requiring only 2-ampere-draw from its ½ hp motor; and the Vibra-Veyor (R), producing up to 200 ft of pan length activated by a single vibrator and featuring balanced mechanical operation without counterweights. *Robins-Conveyors Div., Hewitt-Robins, Inc.*

Ventilating Fans

42—Designed for ductwork applications, two new models of vaneaxial, medium pressure propeller fans prevent swirling and provide a smooth, efficient axial flow of air. Operating on a low horsepower input, units work quietly over wide pressure range and convert air loss ordinarily resulting from turbulence to pressure. Adaptable to almost any type of ventilating requirement, vaneaxial fans are available in Type VCDD direct driven units, constructed with motor inside air stream

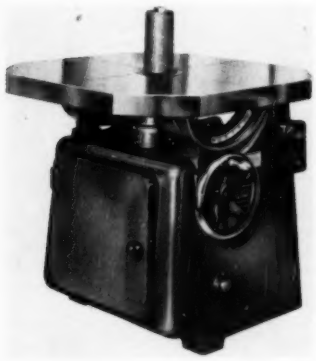
for nonhazardous applications, and Type VCS belt driven for installations in which corrosive or inflammable fumes, dusts and vapors are present. Units are equipped with open-ventilated, ball-bearing, 40 C rise, standard NEMA foot-mounted motors and are easily installed in standard 20 and 40 in. diameter duct systems. *Robbins & Myers, Inc.*

Polishing Belt

43—Rayon-Resin polishing belt is of patent construction with pulley side Neoprene vulcanized to rayon polishing side. In "on the job" tests, Rayon-Resin belts have been used and reset in excess of 650 times in a three-year period and are still in use. Manufacturer claims belts will last in excess of 1000 times in normal use with no raveling and stretch and with shrinkage less than 2 per cent. *Industrial Lubricants Co.*

Oscillating Spindle Sander

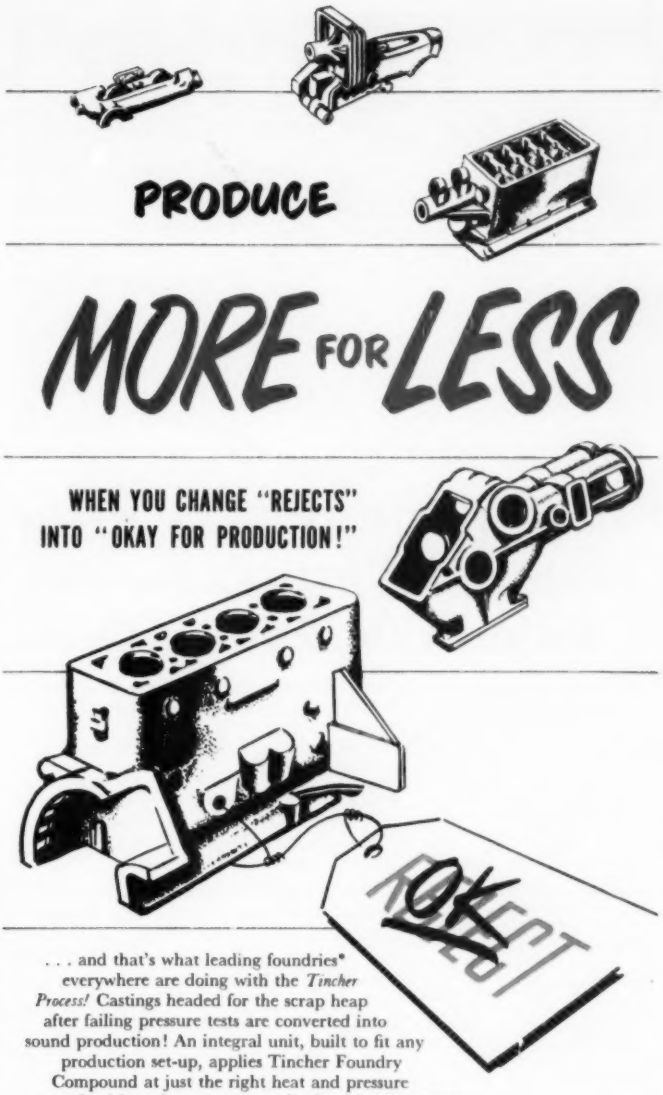
44—Heavy duty oscillating spindle sander for foundry patternshops has large cast iron base with 18 in. diameter rockers, and large cast iron table 37 x 37 in. with removable cast iron throat plates for 2 and 4 in. drums. Drums up to 6 in. diameter can be used in regular table. Totally enclosed, fan cooled 1 hp motor develops 1800 rpm for 3-phase, 60 cycle, either 220 or 440 volts. Motor and spindle tilt 45 degrees forward and 5 degrees back from vertical. Spindle oscillates 1-¼ in. with 56 strokes per min at 1800 rpm. Spindle has vertical adjustment of 3 in. to insure wear on full 9 in. of sanding



sleeves. Standard equipment includes 3 removable spindles 1 x 9 in.; 3 rubber drums 2, 4 and 6 in. diameter; one each sanding sleeves, 2, 4 and 6 in. diameter; one set of two throat blocks for 2 and 4 in. drums; one set of wrenches and ready-wired pushbutton magnetic control. *Oliver Machinery Co.*

Portable Sand Conditioner

45—Sandmaster, a portable sand conditioning unit, performs cutting, magnetic separation, screening and piling of foundry molding sand. Uniquely-designed cutting cylinder cuts, mixes and mulls sand, conditioning synthetic sands quickly and



. . . and that's what leading foundries* everywhere are doing with the *Tincher Process!* Castings headed for the scrap heap after failing pressure tests are converted into sound production! An integral unit, built to fit any production set-up, applies Tincher Foundry Compound at just the right heat and pressure to seal voids and openings completely and permanently.

After machining, the Tincher Process is even more valuable! Costly finished parts like pump housings, engine blocks and automatic transmission housings are saved from rejection due to small casting imperfections uncovered in machining.

Save castings—and save money—with the *Tincher Process!*

TINCHER PRODUCTS COMPANY

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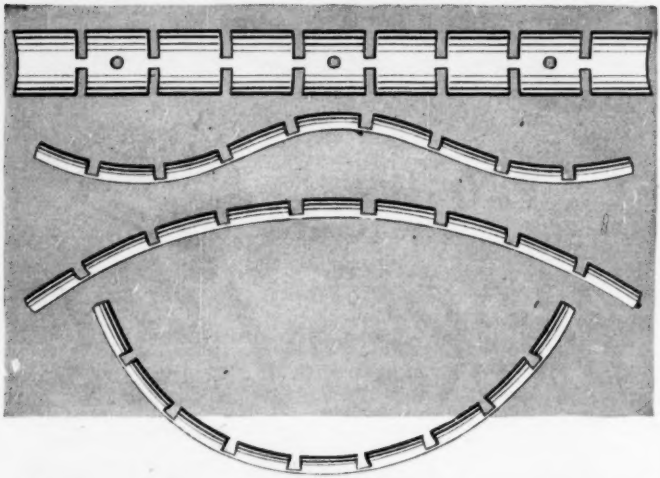
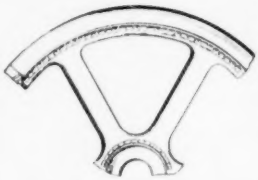
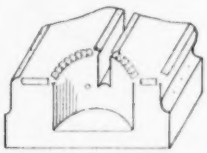
* Names available on request. The Tincher Process is field tested and proved. See our exhibit at the CHICAGO METAL SHOW, October 23-27.



Take the CURVES in HIGH with MILWAUKEE (PATENTED) Adjustable Radius Chills



Adjustable Radius Chills used to chill rim-and-web and hub-and-web fillets in a gear casting.



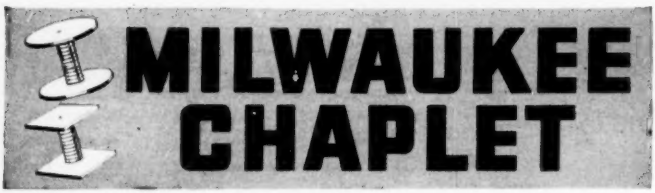
Adjustable Radius Chills in a semi-circular fillet, in 2 sections.

Curved or irregularly shaped fillets hold no fears for foundrymen who have learned how to use these easily adjustable, extremely flexible radius chills to gain one or more of these advantages:

- Quick, easy, hand shaping to fit single or compound curves along the fillets of cores or molds for cylindrical, round or irregularly shaped castings.
- Effective chilling of hub-and-web and rim-and-web fillets of gears and gear blanks.
- Eliminate buckling . . . because the rows of evenly spaced slots provide "room for expansion" when the hot metal contacts the chill.
- Adjustable Radius Chills are easily broken at 1" intervals to accommodate curved or irregular fillets of any length.
- They effect substantial savings in welding and cleaning costs.

Send for Samples and see for yourself that MILWAUKEE Adjustable Radius Chills can bring you these benefits and more.

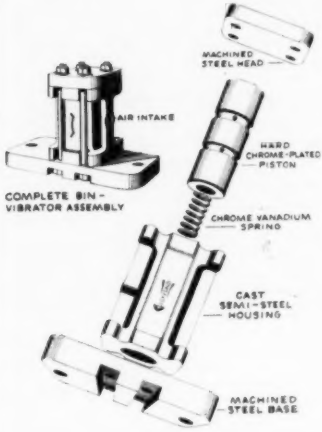
MILWAUKEE CHAPLET & MFG. CO.
1025 S. 40th STREET, MILWAUKEE 4, WISCONSIN



with less bond additions. Machine removes shot and tramp metal by magnetic separation, screens other foreign material and piles sand at molders' benches. Hydraulically steered and easily maneuverable, Sandmaster can be supplied in either gas or electric drive with variable speeds from 4 to 25 fpm for cutting and screening, and 25 to 100 fpm when piling or traveling from floor to floor. *American Wheelabrator & Equipment Corp.*

Air Vibrator

46—Redesigned and simplified, Type "F" Air Vibrator now has only five major parts, reducing maintenance to a minimum and eliminating wear almost entirely. Type "F" Vibrator is applicable to bins, chutes, screens and storage tanks and will move sand, gravel, coal, chemicals, grain, cement and cinders. *Cleveland Vibrator Co.*



Metals Separator Magnets

47—Non-electric Alnico plate magnets for separation of tramp iron from materials in process are available in three models of varying strengths—Extrapower, Ultrapower and Superpower. Claimed by manufacturer to have greater magnetic strength and lighter weight than comparable magnets, Automagnets have five new features: (1) fully-encased magnet castings, (2) riveted parts, (3) aluminum hinges, (4) insulated plate working surface confines magnetic strength to where desired, and (5) flush air gap prevents gathering of fine iron on plate face. *Erie Mfg. Co.*

Pattern Coating

48—Shellastic, a liquid plastic, forms a plastic coating on wood patterns and core boxes which is not "wetted" by molding or core sand and eliminates need for partings of any kind. Plastic coating resists abrasive action of sand and eliminates need for frequent coatings of shellac. Tested in a Buffalo foundry, core box given coat of Shellastic over two coats of shellac made from 700 to 800 cores before revarnishing was necessary. *Exothermic Research Products, Inc.*

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BALL BEARING WHEELS SPIN WITH THE BLADE
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STRONG — DURABLE — PRECISION MADE
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PERSONALITIES

(Continued from Page 71)

Warner B. Bishop has been named manager of foundry sales of the Archer-Daniels-Midland Co. (The Werner G. Smith Co. Division), succeeding **L. P. Robinson**, who was recently elected a vice-president. A graduate of Dartmouth College, Mr. Bishop received his master's degree there prior to serving 3½ years with the Naval Reserve in World War II. Joining the Foundry Division of Archer-Daniels-Midland in

W. B. Bishop

1945, he organized and supervised export activities of the Division until appointed assistant to the sales manager in 1948. Simultaneous appointments announced by the company are Sales Representative **Robert V. Hunter**, to be Eastern sales manager of the A-D-M Werner G. Smith Co. Division's foundry products, and Foundry Research Trainee **John L. Meckel**, to be sales representative for the Division's core oil sales in Minnesota. Both Mr. Hunter and Mr. Meckel are veterans of World War II.

Gordon W. Johnson, chief metallurgist, American Hoist & Derrick Co., St. Paul, Minn., has been named supervisor of Foundry Process Research at the Armour Research Foundation of the Illinois Institute

G. W. Johnson

of Technology. In his new position, Mr. Johnson will supervise research projects in casting techniques and other foundry problems. He is a specialist in alloy cast steels and galvanizing processes. A graduate of the University of Min-

Core Hardness

with

Gordon & Campbell
CORE HARDNESS TESTER

Every foundryman knows that the relative hardness condition of cores tells its tale in the casting. All the advantages of accurate core-hardness control can be obtained with this direct-reading, Gordon-Campbell Core Hardness Tester. The test results are dependable — and obtained easily in a few seconds. No special skill is required.

Write for full particulars.

OTHER Gordon & Campbell TESTING EQUIPMENT:

Combination Rammer-Compression Tester—Simple way to prepare specimens to determine compression strength.
Permtester—A foolproof method for determining sand permeability.
Transverse Test Core Maker—For preparing core specimens for transverse tests.
Transverse Core Tester—Rapidly determines transverse strength of dry sand cores.
Baking Oven—Electrically heated, dries sand samples, bakes core specimens.
Moisture Tester—A reliable method of measuring moisture content.
Sand Mixer—For thorough preparation of sample core-sand mixtures.
Sand Washer—The easy-to-use method to determine clay content of sand.

Each of these testing units was designed to conform with the recommendations of the Committee on Foundry Sand Research of the American Foundrymen's Society.

Complete information upon request.

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Manufacturers & Distributors
Metallurgical Testing Machines • Industrial Furnaces & Ovens • Temperature Control Instruments • Thermocouples & Accessories
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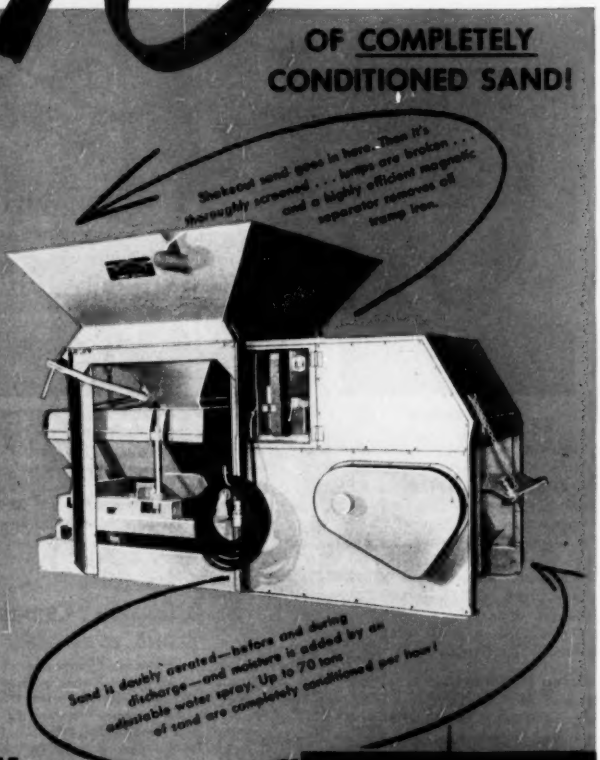
70 TONS PER HOUR—
OF COMPLETELY CONDITIONED SAND!


Sheakout sand goes in here. Then it's thoroughly screened . . . lumps are broken . . . and a highly efficient magnetic separator removes all tramp iron.
Sand is doubly aerated—before and during discharge—and moisture is added by an adjustable water spray. Up to 70 tons of sand are completely conditioned per hour!

THE PREPARATOR

Reduce your costs, produce more per molder, and improve sand and casting quality with complete sand conditioning! The Preparator—efficient, heavy duty, portable—thoroughly conditions up to 70 tons of molding sand per hour. It's built to take the roughest treatment, and all operating mechanism is protected by dust-tight enclosures. Both large and small foundries throughout the world use Preparators . . . let us demonstrate the outstanding Preparator features to you in a neighboring foundry . . . write today!

Perfect balance for crane handling from foundry floor to floor.

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FEMA

nesota in 1938, Mr. Jonson joined American Hoist & Derrick at that time. He is past chairman of the A.F.S. Twin City Chapter.

C. R. Maxon of the New Jersey Zinc Co. was honored by the American Die Casting Institute with presentation of the first Doehler Award "for outstanding achievement contributing to the advancement of the die casting industry" at a ceremony in Chicago September 20. As joint representative of the American Die Casting Institute and the American Zinc Institute in Washington, D. C., and the Canal Zone earlier this year, Mr. Maxon overcame a Government prejudice against use of on-grade zinc die castings, by proving

C. R. Maxon

that on-grade zinc die castings ordered under Government specifications could be relied on to stand up under the most grueling service in tropical climates.

W. O. McFatridge, assistant foundry superintendent, Farmall Works, International Harvester Co., Rock Island, Ill., has been transferred to the Foundry Division of Harvester's new Manufacturing Research Center, Chicago. Equally proficient as a foundryman and as an artist, Mr. McFatridge illustrated the front cover of the September, 1949, issue of AMERICAN FOUNDRYMAN.

James J. Hagan has been appointed assistant plant manager for Weston Electrical Instrument Corp., Newark, N. J. An employee of Weston since 1942, Mr. Hagan was formerly personnel director.

Arthur Lazarus, vice-president of Day & Zimmerman, Inc., engineering and management consultants, has resigned to enter the consulting field in New York City. Mr. Lazarus will specialize in management and budget problems in industry.

Lloyd H. Angstadt has been named director of Remington Rand, Inc.'s newly-opened Institute of Records Administration and Management Controls in New York City. Active during World War II as an executive of the Training Within Industry program, Mr. Angstadt will head an organization devoted to teaching records management and office administration to users of R.R. office equipment.

(Continued on Page 94)

SOLID STEEL HEADS, CAPS and MOUNTINGS MACHINED from SOLID BAR STOCK
CHROME PLATED PISTON
DIRT WIPER SEALS
NON-CORROSIVE BRASS BARRELS
Miller

AIR CYLINDERS

SOLID STEEL HEADS, CAPS and MOUNTINGS. Eliminate dangerous, costly breakage under even the severest operating conditions . . . assuring longest possible cylinder life. Standard construction on ALL Miller Cylinders—*both Air and Hydraulic.*

HARD CHROME PLATED PISTON RODS. 90,000 to 110,000 psi yield point heat treated stress relieved steel, accurately ground, polished, then hard chrome plated for extra high resistance to the scratches that commonly cause leakage.

DIRT WIPERS. Wipe piston rods clean on every "in" stroke, protecting piston rods, seals, and bushings from scratch-damage by dirt, scum, abrasive particles. Standard construction on ALL Miller Cylinders — *both Air and Hydraulic.*

NON-CORROSIVE BRASS BARRELS. Eliminate the rust and corrosion caused by moisture always prevalent in plant air lines. Standard construction on all Miller Air Cylinders.

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COMPLETE MILLER CYLINDER LINE INCLUDES: AIR CYLINDERS, 1½" to 20" BORES, 200 PSI OPERATION; LOW PRESSURE HYDRAULIC CYLINDERS, 1½" TO 6" BORES FOR 500 PSI OPERATION, 8" TO 14" BORES FOR 250 PSI; HIGH PRESSURE HYDRAULIC CYLINDERS, 1½" TO 12" BORES, 2000-3000 PSI OPERATION. ALL MOUNTING STYLES AVAILABLE.

Benefits to you
No Broken Castings
No Scratch-Damage to Piston Rods, Bushings and Seals
NO COSTLY "DOWNTIME"
NO REPAIRS
NO MAINTENANCE
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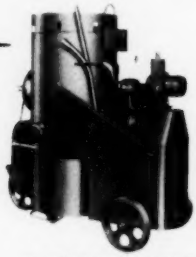
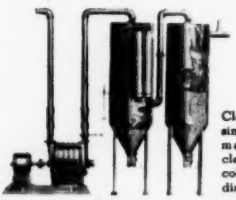


HOFFMAN Heavy-Duty Vacuum Cleaning Equipment Provides These Outstanding Advantages:

New 5 H.P. gasoline engined powered Hoffco-Vac portable operates anywhere in your foundry—independent of electric power.



Clean at several stations simultaneously with Hoffman stationary vacuum cleaning system. Central collection for recovery and disposal.

- *Molds and Cores Cleaned Faster, Better*
- *Fewer "Cut-Eye" Cases* • *Reduced Silicosis Health Hazard* • *Recovery of Shot and Other Materials* • *Improved Housekeeping & Lighting* • *Better Employee Morale* • *Non-Stop Production*
- *Greater Power Economy*

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CANADIAN PLANT CANADIAN HOFFMAN MACHINERY CO. LTD. NEWMARKET, ONT.

PERSONALITIES

(Continued from Page 92)

Charles H. Parcells, who received his master's degree in June from the Illinois Institute of Technology, has been appointed an instructor in metallurgical engineering at the Institute. Holder of a bachelor of science degree from Rensselaer Polytechnic Institute, Mr. Parcells did graduate work at the Carnegie Institute of Technology, before transferring to Illinois Tech in 1947, where for the past year he has been an instructor in the evening division. He is a Navy veteran of World War II.

Edward P. Buchanan has been named manager of the Pig Iron Division of the Pittsburgh Coke & Chemical Co. Mr. Buchanan has been with the company's

E. P. Buchanan

sales organization for 12 years, with the exception of a period during World War II as assistant to the Chief of the Pig Iron Section, War Production Board.

Benjamin Sampson has been named general sales manager of the K. H. Huppert Co., Chicago oven and laboratory and industrial furnace manufacturers. Mr. Sampson formerly was district service manager for Sunbeam Corp., and more recently, manager of the Industrial Furnace and Oven Division of Claud S. Gordon Co.

M. C. Walker, formerly process engineer for the Coated Products Division of the Carborundum Co., Niagara Falls, N. Y., has been named chief chemist of the Michigan Abrasive Co. A graduate of the University of Buffalo, Mr. Walker received the Legion of Merit for his services in the North African campaign in World War II.

Kenneth W. Lineberry, who has been serving as chief executive officer of Black, Sivalls & Bryson, Inc., Kansas City, Mo., for several weeks, was recently elected president of the company, succeeding A. J. Smith who resigned as president and director of the company.

Charles Geesey, chief metallurgist for Superior Foundry, Inc., Cleveland, was honored by the company's managerial and supervisory employees with a testimonial

dinner upon the occasion of his retirement June 30. Mr. Geesey, who started with Superior in 1922, was responsible for many improvements in the company's Metal Control department.

William Rostoker of Toronto, Ont., Canada, a lecturer at the University of Birmingham, England, was recently appointed assistant professor of metallurgical engineering at the Illinois Institute of Technology. Rostoker received both his bachelor and master's degrees in metallurgical engineering from the University of Toronto and was awarded his doctor's degree by Lehigh University in 1948. During 1948 and 1949, he was a research fellow at the University of Birmingham. A specialist in physical metallurgy, he is the author of three major works in this field and in 1945 was awarded the T. A. Russell fellowship at Toronto, and in 1946 the Roy R. Horner fellowship at Lehigh.

Gerhard Kohler, Alfred Gutmann Actien-Gesellschaft fur Maschinenbau, Hamburg, Germany, visited A.F.S. Headquarters during Chicago's First International Trade Fair. His company, an exhibitor in the Fair, manufactures shot and sand blasting equipment, cupolas and coal-fired crucible furnaces. Other international visitors to the National Office in recent weeks were: **P. E. Blincow** of Burn & Co., Ltd., Howrah, West Bengal, India; **Ivar Mathison,** A/S Sandnes Aducerverk, Sandnes, Norway; and **E. D. Barker** and **B. T. Devereaux** of Andrew Thomson & Scougall Pty., Ltd., Sydney, Australia.

OBITUARIES

David G. Anderson, Clarendon Hills, Ill., foundry consultant and former consulting foundry engineer for the National Foundry Association, Chicago, died September 10 at his home in Clarendon Hills. A former general superintendent of the Pittsburgh Engineering Co. and head of the Foundry Development staff of Western Electric Co., Chicago, for many years, Mr. Anderson was a past president of the Chicago Foundrymen's Club and the Swedish Society of Engineers.

William J. Bowers, Sr., 76, pioneer Alabama foundryman and retired general foundry superintendent, American Cast Iron Pipe Co., Birmingham, died August 20 in that city. A native of Virginia, Mr. Bowers first entered the foundry industry in South Pittsburgh, Tenn., joining the American Cast Iron Pipe Co., Birmingham, as a patternmaker in 1897. He retired in 1938 as general foundry superintendent after 28 years' service with the company. Mr. Bowers is survived by his widow, four daughters and four sons, two of whom are prominent Alabama foundrymen—James A., melting superintendent, American Cast Iron Pipe Co., and John J., maintenance superintendent, Central Foundry Co., Holt, Ala.

Charles M. Kepner, 64, sales representative of H. Kramer & Co., Chicago, in the Pittsburgh area, died September 1 following a brief illness.

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Green Strength
Green Deformation
Flowability
Moisture
Rammability

2 EASIER CORE MAKING

Green Strength
Blowability
Sagging Resistance
Cracking Resistance
Stickiness
Moisture

3 BETTER MOLD CONDITION

Green Hardness
Air Set Strength
Dry Strength

4 BETTER CORE CONDITION

Dry Hardness
Core Strength
Core Deflection
Moisture Absorption
Gas Pressure

5 CASTING APPEAL

Permeability
Clay Substance
Fineness
% Combustible

6 CASTING QUALITY

Hot Strength
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Spalling

7 EASIER SHAKE-OUT

Retained Strength

Write for Free New "Foundry Sand Practise" Book

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Abstracts

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Dielectric Core Baking

90—Resin Binders Used. John Dawson, "Electronics Speed Core Drying," *Iron Age*, vol. 165, May 4, 1950, pp. 90-93.

It is claimed that better sand cores are produced more economically in dielectric driers. Some advantages of this method are: drying is done in a matter of seconds or minutes; reduced handling; less floor space required for equipment; fewer workers needed; no wasted power.

Resin Core Binder

91—Baking Time Reduced. Sven Toressson, "Cores for Central Heating Boilers," *Gjuteriet*, vol. 40, June 1950, pp. 81-88 (in Swedish).

The author describes the operation of the AB Götaverken boiler core shop. The cores were previously made from sand bonded with herring oil and flour binder, dried overnight (12-14 hr) in electric batch type ovens. Drying time was reduced to 1¾ hr and the floor space to 1/7 of that needed prior to installation of a continuous oven and the adoption of melamine-formaldehyde resin in place of herring oil. The melamine resin is characterized by fast baking, only faint odor, ready collapsibility and good moisture resistance.

Ductile Iron Specifications

92—List Minimum Properties. A. P. Gagnebin, "INCO write Specs for Ductile Iron," *Iron Age*, vol. 165, May 4, 1950, pp. 89.

A suggested U. S. specification for the purchase of ductile iron is presented. Four grades are listed in table form showing the minimum mechanical properties for each group.

Nodular Iron Production Factors

93—Additions Efficiency. J. E. Rehder, "Nodular Cast Irons," *Canadian Metals*, vol. 13, June 1950, pp. 16-18, 21, 46-47.

The foundry methods for producing nodular iron are described and its various properties are discussed. The final composition of the iron after treatment is given as follows:

Total carbon, per cent	3.40 - 3.60
Silicon, per cent	2.50 - 3.00
Manganese, per cent	0.40 max.
Phosphorus, per cent	0.15 max.

The sulphur content is kept as low as practicable before treatment in order to keep the amount and cost of the magnesium addition agent down. The temperature of the molten iron before treatment (for the above mentioned chemical analysis) does not have to be

HIGH SILICON IRON

JISCO

T. M. Reg.

SILVERY

A

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PRODUCT

Metallurgically PURE
Physically Clean
and Uniform

The choice of foundrymen who demand the best

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JACKSON OHIO

"OLIVER"

Single Surfacer

for pattern shops

Takes stock up to 30 inches wide, 8 inches thick. One-piece base assures permanent, accurate alignment of parts. One-piece upper housing. Feed mechanism enclosed for safety and longer life. Enclosed worm gear drive for feed rolls. All revolving parts mounted on ball bearings. Unique chipbreaker. Hand brake brings cylinder to a quick stop. Write for Bulletin No. 261.

"Oliver" makes a full line of Surfacers, Jointers and other woodworking machinery for pattern shops.

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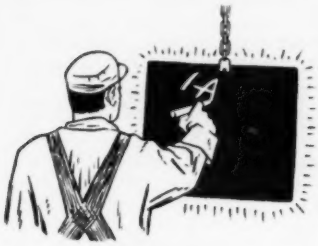
METAL MARKING CRAYONS



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up to 600%....
....cut costs
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2650 F. The temperature of the iron is important since the efficiency of the magnesium agents decreases as the temperature of the iron increases. Some of the points covered in the making of the iron are—base iron composition, type of addition agent, method of addition, post-inoculant, control methods, costs and applications.

Cast Iron Crankshafts

94—Properties and Design. Alexander Finlayson, "Gray Iron Preferred for Large, Heavy Duty Crankshafts," *Materials and Methods*, vol. 31, June 1950, pp. 69-71.

The author describes three different types of gray iron used by his company in making crankshafts for diesel engines. The rough castings range in weight from 500 to 5000 lb and 6 to 18 ft in over-all length. The shafts are designed with hollow throws and journals for engines having 5 to 12 cylinders and horsepower ratings up to 2400. The engineering properties, design considerations, and a comparison between cast iron and steel are also described.

Graphite Facing Mixture

95—Tensile Strength Increased. Vladimir A. Grodsky, "Castings Improved by the Use of Graphite Molding Material," *Metal Progress*, vol. 58, July 1950, pp. 60-62.

Castings with improved mechanical properties were obtained by using a layer of graphite molding mixture ½ to 1 in. thick backed by ordinary molding sand. The layer acts as a chill. The tensile strength of some aluminum alloys has been increased as much as 22 per cent by using the chilling layer. Increases of 7.95 and 13.6 per cent for phosphor bronze and gun metal castings, respectively, are also reported.

Nodular Iron Magnesium Determinations

96—Analytical Method. Ford R. Bryan, G. A. Nahstoll and H. D. Veldhuis, "Spectrographic Determination of Magnesium in Nodular Iron," *The Foundry*, vol. 78, June, 1950, pp. 102-103, 244-248.

A procedure consisting of two parts for the spectrographic determination of magnesium in nodular iron is described. First, a spectrographic solution method of analyzing metal rods to be used as standards for the control analysis; and second, a technique for determining magnesium as a part of the customary spectrographic analysis of cast iron rods or pins. Working curves for low and high magnesium ranges and an analytical curve based upon synthetic solutions are shown and discussed in the article.

Core Gas Liberation

97—Prevention Methods. H. L. Campbell, "Casting Defects Caused by Core Gases," *The Foundry*, vol. 78, June 1950, pp. 86-87, 210, 212-213.

The mechanism by which gases are liberated from cores is described along with some of the defects they produce when trapped in the metal before it solidifies. The methods by which gas holes may be prevented are discussed. Seven figures and one table are included.

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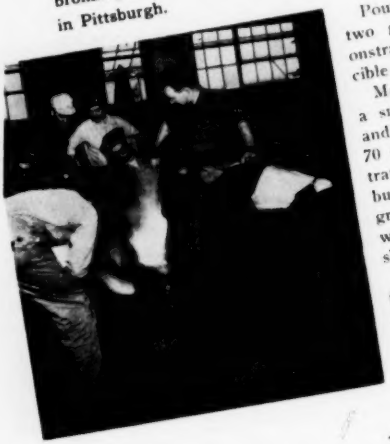

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